

Received Event (Event Succeeded)

Date: 12/16/98 Time: 3:57 P.M.
Pages: 25 Sender: 914 945 4073
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Company: Type: Fax P.23/25

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

GROUP 1700

**In re Patent Application of
J. Bednorz et al.**

Date: December 15, 1998

Serial No. 08/303,561

Group Art Unit: 1105

Filed: September 9, 1994

Examiner: M. Kopec

**For: NEW SUPERCONDUCTIVE COMPOUNDS HAVING HIGH TRANSITION
TEMPERATURE, AND METHODS FOR THEIR USE AND PREPARATION**

AFFIDAVIT UNDER 37 C.F.R. 1.132

**Commissioner of Patents and Trademarks
Washington, D. C. 20231**

Sir:

I, Timothy Dinger, being duly sworn, do hereby depose and state:

That I received a B. S. degree in Ceramic Engineering (1981) from New York State College of Ceramics, Alfred University, an M. S. degree (1983) and a PhD. degree (1986), both in Material Science from the University of California at Berkley.

That I have worked as a research staff member in Material Science at the Thomas Watson Research Center of the International Business Machines Corporation in Yorktown Heights, NY from 1986 to the present.

That I have worked in the fabrication of and characterization of high temperature superconductor materials from 1987 to 1991.

That I have reviewed the above-identified patent application and acknowledge that it represents the work of Bednorz and Muller, which is generally recognized as the first discovery of

YO987-074BY

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superconductivity above 26°K and that subsequent developments in this field have been based on this work.

That all the high temperature superconductors which have been developed based on the work of Bednorz and Muller behave in a similar way, conduct current in a similar manner and have similar magnetic properties.

That once a person of skill in the art knows of a specific transition metal oxide composition which is superconducting above 26°K, such a person of skill in the art, using the techniques described in the above-identified patent application, which includes all known principles of ceramic fabrication known at the time the application was filed, can make the transition metal oxide compositions encompassed by the claims in the above identified application, without undue experimentation or without requiring ingenuity beyond that expected of a person of skill in the art. This is why the work of Bednorz and Muller was reproduced so quickly after their discovery and why so much additional work was done in this field within a short period of their discovery.

The general principles of ceramic science referred to by Bednorz and Mueller in their patent application can be found in many books and articles published before their discovery. An exemplary list of books describing the general principles of ceramic fabrication are:

- 1) Introduction to Ceramics, Kingery et al., Second Edition, John Wiley & Sons, 1976, in particular pages 5-20, 269-319, 381-447 and 448-513, a copy of which is with the Affidavit of Thomas Shaw submitted December 15, 1998
- 2) Polar Dielectrics and Their Applications, Burfoot et al., University of California Press, 1979, in particular pages 13-33, a copy of which is with the Affidavit of Thomas Shaw submitted December 15, 1998.
- 3) Ceramic Processing Before Firing, Onoda et al., John Wiley & Sons, 1978, the entire book, a copy of which is with the Affidavit of Thomas Shaw submitted December 15, 1998.

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4) Structure, Properties and Preparation of Perovskite-Type Compounds, F.S. Glasso, Pergamon Press, 1969, in particular pages 159-186, a copy of which is with the Affidavit of Thomas Shaw submitted December 15, 1998.

An exemplary list of articles applying their general principles of ceramic fabrication to the types of materials described in applicants' specification are (these references are cited on applicant's 1449 form submitted August 5, 1987 and in PTO Form 892 in Paper # 20, Examiner's action dated August 8, 1990):

- 1) Oxygen Defect K_2NiF_4 - Type Oxides: The Compounds $La_{2-x} Sr_x CuO_{4-x/2+\delta}$, Nguyen et al., Journal of Solid State Chemistry 39, 120-127 (1981).
- 2) The Oxygen Defect Perovskite $BaLa_4 Cu_5-O_{13.4}$, A Metallic Conductor , C. Michel et al., Mat. Res. Bull., Vol. 20, pp. 667-671, 1985.
- 3) Oxygen intercalation in mixed valence copper oxides related to the perovskite, C. Michel et al., Revue de Chemie minerale, p. 407, 1984.
- 4) Thermal Behaviour of Compositions in the Systems $x BaTiO_3 + (1-x) Ba(Ln_0, B_{0.5}) O_3$, V.S. Chincholkar et al. Therm. Anal. 6th, Vol. 2, p. 251-6, 1980.

By: Timothy R. Dinger
Timothy Dinger

Sworn to before me this 16th day of December, 1998

Sandra M. Emma

Notary Public

SANDRA M. EMMA
Notary Public, State of New York
No. 01PO4935290
Qualified in Westchester County
Commission Expires July 5, 2002

YO987-074BY

Attachment A

#11

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NUMBER OF PATENTS FOUND WITH YOUR REQUEST THROUGH:
LEVEL 1... 68

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*****06068*****
LEVEL 1 - 1 OF 68 PATENTS

5,670,078

<=2> GET 1st DRAWING SHEET OF 7

Sep. 23, 1997

Magnetic and nonmagnetic particles and fluid, methods of
making and methods of using the same

INVENTOR: Ziolo, Ronald F., Webster, New York

DETDESC:

... described in U.S. Pat. No. 4,474,886 to Ziolo. Examples of the precursor
ions which may be used includes those derivable from transition metal ions, such
as iron, cobalt, nickel, manganese, vanadium, chromium, rare earths and the
like. In the case of a non-magnetic colloid, this may include ions of, for
example, sulfur, selenium, gold, barium, cadmium, copper, silver, manganese,
molybdenum, zirconium, gallium, arsenic, indium, tin, ...

... ions which can be incorporated into the resin beads to form both

A 1

single-domain and multidomain magnetic particles include: those derivable from transition metal ions, such as iron, cobalt, nickel, manganese, vanadium, chromium, rare earths and the like. These ions generally exist in the form of chlorides of the metal involved such as ferrous chloride, ferric chloride, copper chloride, nickel chloride, and the like. The corresponding iodides, bromides and fluorides may also be suitable. . . .

LEVEL 1 - 2 OF 68 PATENTS

5,663,319

Sep. 2, 1997

Probe compositions for chromosome identification and methods

INVENTOR: Bittner, Michael L., Naperville, Illinois
Morrison, Larry E., DuPage County, Illinois
Legator, Mona S., Chicago, Illinois

SUM:

. . . capable of reacting, and a fluorophore group may have already reacted, with a linking group. A fluorescent compound may include an organic chelator which binds a luminescent inorganic ion such as a rare earth like terbium, europium, ruthenium, or the like.

The term "linking compound" or "linking group" as used herein generally refers to a hydrocarbonaceous moiety. A linking compound is capable of reacting, and a linking group may have . . .

LEVEL 1 - 3 OF 68 PATENTS

5,601,934

<=2> GET 1st DRAWING SHEET OF 1

Feb. 11, 1997

Memory disk sheet stock and method

INVENTOR: Bartges, Charles W., Delmont, Pennsylvania
Baumann, Stephen E., Penn Hills, Pennsylvania
Hyland, Jr., Robert W., Oakmont, Pennsylvania
Jensen, Craig L., Pittsburgh, Pennsylvania
Tarcy, Gary P., Plum, Pennsylvania
Vinnedge, K. Dean, Bettendorf, Iowa
Skeen, Troy C., Bettendorf, Iowa

DETDESC:

. . . automatically grouped with this same series of elements even though it often performs the same function as scandium, or other "true" rare earths in an alloy composition. It is believed that minor amounts of still other rare earths, like erbium, thulium, lutetium, ytterbium, or another rare earth "act-alike", like hafnium, may be substituted for, or possibly even combined with scandium (or with each other) in varying quantities to achieve the . . .

LEVEL 1 - 4 OF 68 PATENTS

5,593,951

<=2> GET 1st DRAWING SHEET OF 4

Jan. 14, 1997

Epitaxy of high T[C]superconductors on silicon

INVENTOR: Himpsel, Franz J., Mt. Kisco, New York

SUM:

. . . as well as to understand the basic mechanisms for superconductivity in this class of materials.

A2

Bednorz and Mueller first showed superconducting behavior in mixed copper-oxides, typically including rare earth and/or rare earth-like elements and alkaline earth elements, for example La, Ba, Sr, . . . , and having a perovskite-like structure.

Materials including the so called "1-2-3" phase in the Y-Ba-Cu-O . . .

DETDESC:

. . . EMBODIMENTS

A technique is provided for depositing high T_c superconducting copper-oxide based materials epitaxially on Si (001). Typically, these classes of superconducting materials include a rare earth or rare earth-like element and/or an alkaline earth element. Representative formulas for such materials are the following:

(A[1- χ]B χ)₂Cu ω [4- ε]

and

A₁B₂Cu₃O_{7-ε}

where A is a trivalent element (e.g., . . .

. . . in the art that the present invention applies to epitaxial structures including silicon (001) surfaces and any copper oxide superconductor thereon. Thus, the teaching of this invention can include copper-oxide based compositions having any combinations of rare earth or rare earth-like elements and/or alkaline earth elements as well as copper oxide superconductors which do not contain rare earth elements. Further, it will be apparent to those of skill in the art that the Si (001) surface is . . .

LEVEL 1 - 5 OF 68 PATENTS

5,573,574

Nov. 12, 1996

Electrorefined aluminium with a low content of uranium,
thorium and rare earths

INVENTOR: Leroy, Michel, St. Egreve, France

SUM:

. . . applications specifies a minimum Al content of above 99.9995%, (and even sometimes above 99.9997%) and a U + Th content of less than 1 ppb, and even sometimes less than 0.3 or 0.1 ppb.

Rare earths, some of which, like samarium, have a significant alpha radioactivity, are also undesirable. By way of example, 10 ppb of natural samarium emits as many alpha particles as 0.1 ppb of uranium 238. The high purity . . .

LEVEL 1 - 6 OF 68 PATENTS

5,569,759

<=2> GET 1st DRAWING SHEET OF 25

Oct. 29, 1996

Water soluble texaphyrin metal complex preparation

INVENTOR: Sessler, Jonathan L., Austin, Texas
Hemmi, Gregory W., Austin, Texas
Mody, Tarak D., Austin, Texas

DETDESC:

A3

... C), 10.24 (s, 2 H, ArH), 12.23 (s, 2 H, CH=N); UV/vis: λ [max] 420.0, 477.5, 730.0; FAB MS M< + > 811.

Other lanthanide and rare earth-like metal complexes may be synthesized including the Gd< + 3>, Lu< + 3>, La< + 3>, In< + 3>, and Dy< + 3> complexes.

EXAMPLE 4

Synthesis of B2T2 TXP, see FIGS. 7A and ...
LEVEL 1 - 7 OF 68 PATENTS

5,567,564

<=2> GET 1st DRAWING SHEET OF 7

Oct. 22, 1996

Liquid development composition having a colorant comprising a stable dispersion of magnetic particles in an aqueous medium

INVENTOR: Ziolo, Ronald F., Webster, New York

DETDESC:

... described in U.S. Pat. No. 4,474,886 to Ziolo. Examples of the precursor ions which may be used includes those derivable from transition metal ions, such as iron, cobalt, nickel, manganese, vanadium, chromium, rare earths and the like. In the case of a non-magnetic colloid, this may include ions of, for example, sulfur, selenium, gold, barium, cadmium, copper, silver, manganese, molybdenum, zirconium, gallium, arsenic, indium, tin, ...

... ions which can be incorporated into the resin beads to form both single-domain and multidomain magnetic particles include: those derivable from transition metal ions, such as iron, cobalt, nickel, manganese, vanadium, chromium, rare earths and the like. These ions generally exist in the form of chlorides of the metal involved such as ferrous chloride, ferric chloride, copper chloride, nickel chloride, and the like. The corresponding iodides, bromides and fluorides may also be suitable. ...

LEVEL 1 - 8 OF 68 PATENTS

5,554,428

Sep. 10, 1996

Memory disk sheet stock and method

INVENTOR: Bartges, Charles W., Delmont, Pennsylvania
Hayland, Jr., Robert W., Oakmont, Pennsylvania
Jensen, Craig J., Pittsburgh, Pennsylvania
Baumann, Steven F., Penn Hills, Pennsylvania (Rule 47 Application)

SUM:

... automatically grouped with this same series of elements even though it often performs the same function as scandium, or other "true" rare earths in an alloy composition. It is believed that minor amounts of still other rare earths, like erbium, thulium, lutetium, ytterbium, or another rare earth "act-alike", like hafnium, may be substituted for, or possibly even combined with scandium (or with each other) in varying quantities to achieve the ...

LEVEL 1 - 9 OF 68 PATENTS

5,504,205

<=2> GET 1st DRAWING SHEET OF 25

Apr. 2, 1996

Reduced sp<3> texaphyrins

INVENTOR: Sessler, Jonathan L., Austin, Texas
Hemmi, Gregory W., Austin, Texas
Mody, Tarak D., Austin, Texas

DETDESC:

... 2H, CH=C), 10.24 (s, 2H, ArH), 12.23 (s, 2H, CH=N); UV/vis: lambda max 420.0, 477.5, 730.0; FAB MS M<+> 811.

Other lanthanide and rare earth-like metal complexes may be synthesized including the Gd<+3>, Lu<+3>, La<+3>, In<+3> and Dy<+3> complexes.

EXAMPLE 4

Synthesis of B2T2 TXP, see FIG. 7.

PAGE

... LEVEL 1 - 10 OF 68 PATENTS

5,491,224

Feb. 13, 1996

Direct label transaminated DNA probe compositions for chromosome identification and methods for their manufacture

INVENTOR: Bittner, Michael L., 1768 Brookdale Rd., Naperville, Illinois 60563
Morrison, Larry E., 21 W. 559 Kensington Rd., Glen Ellyn, Illinois 60137
Legator, Mona S., 6540 N. Francisco, Chicago, Illinois 60645

DETDESC:

... capable of reacting, and a fluorophore group may have already reacted, with a linking group. A fluorescent compound may include an organic chelator which binds a luminescent inorganic ion such as a rare earth like terbium, europium, ruthenium, or the like.

The term "linking compound" or "linking group" as used herein generally refers to a hydrocarbonaceous moiety. A linking compound is capable of reacting, and a linking group may have ...

LEVEL 1 - 11 OF 68 PATENTS

5,475,104

<=> GET 1st DRAWING SHEET OF 26

Dec. 12, 1995

Water soluble texaphyrin metal complexes for enhancing relaxivity

INVENTOR: Sessler, Jonathan L., Austin, Texas
Hemmi, Gregory W., Austin, Texas
Mody, Tarak D., Austin, Texas

DETDESC:

... 2H, CH=C), 10.24 (s, 2H, ArH), 12.23 (s, 2H, CH=N); UV/vis lambda max 420.0, 477.5, 730.0; FAB MS M<+> 811.

Other lanthanide and rare earth-like metal complexes may be synthesized including the Gd<+3>, Lu<+3>, La<+3>, In<+3> and Dy<+3> complexes.

EXAMPLE 4

Synthesis of B2T2 TXP, see FIGS. 7A and ...

LEVEL 1 - 12 OF 68 PATENTS

5,457,183

. <=2> GET 1st DRAWING SHEET OF 51

Oct. 10, 1995

Hydroxylated texaphyrins

INVENTOR: Sessler, Jonathan L., Austin, Texas
Mody, Tarak D., Sunnyvale, California
Hemmi, Gregory W., Sunnyvale, California
Kral, Vladimir, Na Kozaaoa, Czechoslovakia

DETDESC:

... 2H, CH=C), 10.24 (s, 2H, ArH), 12.23 (s, 2H, CH=N); UV/vis: lambda max 420.0, 477.5, 730.0; FAB MS M< + > 811.

Other lanthanide and rare earth-like metal complexes may be synthesized in a similar manner including the La< + 3>, Nd< + 3>, Sm< + 3>, Eu< + 3>, Gd< + 3>, Dy< + 3> and Tm< + 3> complexes.

PAGE

...

LEVEL 1 - 13 OF 68 PATENTS

5,451,576

<=2> GET 1st DRAWING SHEET OF 26

Sep. 19, 1995

Tumor imaging and treatment by water soluble texaphyrin metal complexes

INVENTOR: Sessler, Jonathan L., Austin, Texas
Hemmi, Gregory W., Austin, Texas
Mody, Tarak D., Austin, Texas

DETDESC:

... 2H, CH=C), 10.24 (s, 2H, ArH), 12.23 (s, 2H, CH=N); UV/vis: lambda max 420.0, 477.5, 730.0; FAB MS M< + > 811.

Other lanthanide and rare earth-like metal complexes may be synthesized including the Gd< + 3>, Lu< + 3>, La< + 3>, In< + 3> and Dy< + 3> complexes.
EXAMPLE 4

Synthesis of B2T2 TXP, see FIGS. 7A and ...

LEVEL 1 - 14 OF 68 PATENTS

5,447,906

Sep. 5, 1995

Thin film high TC oxide superconductors and vapor deposition methods for making the same

INVENTOR: Chaudhari, Praveen, Briarcliff Manor, New York
Gambino, Richard J., Yorktown Heights, New York
Koch, Roger H., Amawalk, New York
Lacey, James A., Mahopac, New York
Laibowitz, Robert B., Peekskill, New York
Viggiano, Joseph M., Wappingers Falls, New York

ABST:

... films are produced by vapor deposition processes using pure metal sources for the metals in the superconducting compositions, where the metals include multi-valent nonmagnetic transition metals, rare earth elements and/or rare earth-like elements and alkaline earth elements. The substrate is exposed to oxygen during vapor deposition, and, after formation of the film, there is at least one annealing step in an oxygen ambient and slow cooling over several

hours to room temperature. The substrates chosen are not critical as long as they are not adversely reactive with the superconducting oxide film. Transition metals include Cu, Ni, Ti and V, while the rare earth-like elements include Y, Sc and La. The alkaline earth elements include Ca, Ba and Sr.

SUM:

... material in the last decade, wherein the critical transition temperature T_c at which the material becomes superconducting was increased substantially.

Bednorz and Mueller described copper oxide material including a rare earth element, or rare earth-like element, where the rare earth element could be substituted for by an alkaline earth element such as Ca, Ba or Sr.

The work of Bednorz and Mueller has led to intensive investigation in many laboratories in ...

... 400 K. and methods for making these films, where the films exhibit perovskite-like structure.

It is another object of this invention to provide transition metal oxide superconductive films including a rare earth element, or rare earth-like element, where the films exhibit superconductivity at temperatures greater than 400 K., and methods for making these films.

It is another object of the present invention to provide films having the nominal composition $ABO_3 - y$ or ABO_y ...

... provide superconductive oxide films having the nominal composition $AB_2Cu_3O_9 - y$, and methods for making these films, where the films are superconducting at temperatures in excess of 400 K. and A is a rare earth or rare earth-like element, B is an alkaline earth element, and y is sufficient to satisfy valence demands of the composition.

Pat. No. 5447906, *

It is another object of the present invention to provide smooth, continuous copper oxide superconducting films having a perovskite-like ...

... films being smooth and continuous and exhibiting substantial compositional uniformity. In particular, the films are comprised of transition metal oxides containing a superconducting phase, and typically include a rare earth element or rare earth-like element. These rare earth-like elements include Y, Sc and La. Additionally, the rare earth or rare earth-like elements can be substituted for by an alkaline earth element selected from the group consisting of Ca, Ba, and Sr. The transition metals are multi-valent, non-magnetic elements selected from the group consisting of ...

DETDESC:

... especially a T_c in excess of liquid nitrogen temperatures. These films are characterized by the presence of a transition metal oxide and typically by the presence of a rare earth element and/or a rare earth-like element which can be substituted for by an alkaline earth. The transition metal element is a multi-relent nonmagnetic element while the alkaline earth element is selected from the group consisting of Ca, Ba, and Sr. The rare earth-like elements include Y, Sc, and La. The nonmagnetic transition metal is selected from the group consisting of Cu, Ni, Ti, and V. Of these, Cu is the most favorable, yielding film properties which are unique and unexpected.

In the further ...

LEVEL 1 - 15 OF 68 PATENTS

5,439,570

<=2> GET 1st DRAWING SHEET OF 26

Aug. 8, 1995

Water soluble texaphyrin metal complexes for singlet oxygen

production

INVENTOR: Sessler, Jonathan L., Austin, Texas
Hemmi, Gregory W., Austin, Texas
Mody, Tarak D., Austin, Texas

DETDESC:

... 2H, CH=C), 10.24 (s, 2H, ArH), 12.23 (s, 2H, CH=N); UV/vis: lambda max 420.0, 477.5, 730.0; FAB MS M< + > 811.

Other lanthanide and rare earth-like metal complexes may be synthesized including the Gd< + 3>, Lu< + 3>, La< + 3>, In< + 3> and Dy< + 3> complexes.

EXAMPLE 4

Synthesis of B2T2 TXP, see FIGS. 7A and ...
LEVEL 1 - 16 OF 68 PATENTS

5,432,171

<=2> GET 1st DRAWING SHEET OF 26

Jul. 11, 1995

Water soluble texaphyrin metal complexes for viral deactivation

INVENTOR: Sessler, Jonathan L., Austin, Texas
Hemmi, Gregory W., Austin, Texas
Mody, Tarak D., Austin, Texas

DETDESC:

... 2H, CH=C), 10.24 (s, 2H, ArH), 12.23 (s, 2H, CH=N); UV/vis: lambda max 420.0, 477.5, 730.0; FAB MS M< + > 811.

Other lanthanide and rare earth-like metal complexes may be synthesized including the Gd< + 3>, Lu< + 3>, La< + 3>, In< + 3> and Dy< + 3> complexes.

EXAMPLE 4

Synthesis of B2T2 TXP, see FIGS. 7A and ...
LEVEL 1 - 17 OF 68 PATENTS

5,362,582

Nov. 8, 1994

Battery separator

INVENTOR: Chang, Victor S., Ellicott City, Maryland
Hartwig, Richard C., Laurel, Maryland
Lundquist, Joseph T., Gilroy, California
Parham, Marc E., Bedford, Massachusetts
Kung, James K., Lexington, Massachusetts
Avtges, James A., Belmont, Massachusetts
Laccetti, Anthony J., North Andover, Massachusetts

SUM:

... say the particulate filler must be inert with respect to such end use battery environment. Therefore, alkali insoluble particulate such as zirconia and titanium dioxide (preferred), oxides, hydroxides and carbonates of calcium, magnesium, iron, rare earth and the like should be used only in sheet products which ultimately are formed into battery separators for alkaline batteries. Similarly, acid insoluble particulates such as silica (a precipitated silica is preferred), and the like should be ...

LEVEL 1 - 18 OF 68 PATENTS

5,358,659

<=2> GET 1st DRAWING SHEET OF 5

Oct. 25, 1994

Magnetic materials with single-domain and multidomain
crystallites and a method of preparation

INVENTOR: Ziolo, Ronald F., Webster, New York

DETDESC:

... Ions which can be incorporated into the resin beads to form both single-domain and multidomain magnetic particles include: those derivable from transition metal ions, such as iron, cobalt, nickel, manganese, vanadium, chromium, rare earths and the like. These ions generally exist in the form of chlorides of the metal involved such as ferrous chloride, ferric chloride, copper chloride, nickel chloride, and the like. The corresponding iodides, bromides and fluorides may also be suitable. ...

PAGE 20

LEVEL 1 - 19 OF 68 PATENTS

5,322,756

<=2> GET 1st DRAWING SHEET OF 3

Jun. 21, 1994

Magnetic fluids and method of preparation

INVENTOR: Ziolo, Ronald F., Webster, New York

DETDESC:

... several different ions including ferrous or ferric ions. Examples of the precursor ions which may be used includes those derivable from transition metal ions, such as iron, cobalt, nickel, manganese, vanadium, chromium, rare earths and the like. These ions generally exist in the form of chlorides of the metal involved, such as ferrous chloride, ferric chloride, copper chloride, nickel chloride, and the like. The corresponding iodides, bromides and fluorides may also be suitable. ...

LEVEL 1 - 20 OF 68 PATENTS

5,304,966

<=2> GET 1st DRAWING SHEET OF 4

Apr. 19, 1994

Method of adjusting a frequency response in a
three-conductor type filter device

INVENTOR: Hino, Seigo, Nagoya, Japan
Ito, Kenji, Nagoya, Japan

SUM:

... each other. Each of the dielectric substrates 1 and 2 may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 1 is provided with an external ground conducting layer 3 on the peripheral portion and bottom surface thereof. Similarly, the upper dielectric substrate 2 is provided with an external ground conducting layer 4 on the ...

DETDESC:

... assembling of the filter. Each of the dielectric substrates 21 and 22 may be of dielectric ceramic material having a high dielectric constant and a lower

dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 21 is provided with an external ground conductor layer 23 on the peripheral portion and outer surface thereof. Similarly, the upper dielectric substrate 22 is provided with an external ground conductor layer 24 on the ...

LEVEL 1 - 21 OF 68 PATENTS

5,296,458

<=2> GET 1st DRAWING SHEET OF 4

Mar. 22, 1994

Epitaxy of high T c superconducting films on (001) silicon surface

INVENTOR: Himpel, Franz J., Mt. Kisco, New York

SUM:

... as well as to understand the basic mechanisms for superconductivity in this class of materials.

Bednorz and Mueller first showed superconducting behavior in mixed copper-oxides, typically including rare earth and/or rare earth-like elements and alkaline earth elements, for example La, Ba, Sr, . . . , and having a perovskite-like structure. Materials including the so called "1-2-3" phase in the Y-Ba-Cu-O ...

DETDESC:

... EMBODIMENTS

A technique is provided for depositing high T c superconducting copper-oxide based materials epitaxially on Si (001). Typically, these classes of superconducting materials include a rare earth or rare earth-like element and/or an alkaline earth element. Representative formulas for such materials are the following:

(A 1 - x B x)₂CuO₄ - epsilon and A₁B₂Cu₃O₇ - epsilon

where A is a trivalent element (e.g., La, Y, and ...

... in the art that the present invention applies to epitaxial structures including silicon (001) surfaces and any copper oxide superconductor thereon. Thus, the teaching of this invention can include copper-oxide based compositions having any combinations of rare earth or rare earth-like elements and/or alkaline earth elements as well as copper oxide superconductors which do not contain rare earth elements. Further, it will be apparent to those of skill in the art that the Si (001) surface is ...

LEVEL 1 - 22 OF 68 PATENTS

5,291,162

<=2> GET 1st DRAWING SHEET OF 7

Mar. 1, 1994

Method of adjusting frequency response in a microwave strip-line filter device

INVENTOR: Ito, Kenji, Nagoya, Japan
Shimizu, Hiroyuki, Nagoya, Japan
Oguchi, Hotaka, Nagoya, Japan

SUM:

... type which comprises a pair of dielectric substrates 1a and 1b made of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂ or BaO-TiO₂-rare earth or the like, the

dielectric substrates 1a and 1b being stacked to each other. The dielectric substrates 1a and 1b are provided with external ground conducting layers 2a and 2b on the peripheral portion and bottom surface thereof, respectively. On the upper ...

DETDESC:

... assembling of the filter. Each of the dielectric substrates 11 and 12 may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 11 is provided with an external ground conducting layer 13 on the peripheral portion and outer surface thereof. Similarly, the upper dielectric substrate 12 is provided with an external ground conducting layer 14 on the ...

... a pair of piezoelectric substrates 11 and 12 each of which may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The dielectric substrates 11 and 12 are provided with external ground conducting layers 13 and 14 on the peripheral portions and outer surfaces thereof, respectively. These ground conducting layers 13 and 14 may be formed by ...

LEVEL 1 - 23 OF 68 PATENTS

5,278,140

<=2> GET 1st DRAWING SHEET OF 5

Jan. 11, 1994

Method for forming grain boundary junction devices using high T c superconductors

INVENTOR: Chaudhari, Praveen, Briarcliff Manor, New York
Chi, Cheng-Chung J., Yorktown Heights, New York
Dimos, Duane B., Montclair, New Jersey
Mannhart, Jochen D., Metzingen, New York, Federal Republic of Germany
Tsuei, Chang C., Chappaqua, New York

SUM:

... as well as to understand the basic mechanisms for superconductivity in this class of materials.

Bednorz and Mueller first showed superconducting behavior in mixed copper-oxides, typically including rare earth and/or rare earth-like elements and alkaline earth elements, for example La, Ba, Sr, . . . , and having a perovskite-like structure. Materials including the so called "1-2-3" phase in the Y-Ba-Cu-O ...

... excess of about 300 K are generally known as "high T c superconductors", and will be referred to in that manner throughout the specification. This designation is meant to include both the materials having rare earth or rare earth-like elements in their crystalline structure, as well as the more recently reported materials which do not contain rare earth or rare earth-like elements. Generally, all these materials are copper oxide based superconductors having Cu-O planes that appear to be primarily responsible for carrying the supercurrents, where the copper oxide planes are separate or in groups separated by the ...

LEVEL 1 - 24 OF 68 PATENTS

5,252,720

<=2> GET 1st DRAWING SHEET OF 25

Oct. 12, 1993

Metal complexes of water soluble texaphyrins

INVENTOR: Sessler, Jonathan L., Austin, Texas

B All

Hemmi, Gregory W., Austin, Texas
Mody, Tarak D., Austin, Texas

DETDESC:

... 2H, CH=C), 10.24 (s, 2H, ArH), 12.23 (s, 2H, CH=N) ; UV/vis: lambda max 420.0, 477.5, 730.0; FAB MS M<+> 811.

Other lanthanide and rare earth-like metal complexes may be synthesized including the Gd<+3>, Lu<+3>, La<+3>, In<+3> and Dy<+3> complexes.

EXAMPLE 4

Synthesis of B2T2 TXP, see FIG. 7

... PAGE

LEVEL 1 - 25 OF 68 PATENTS

5,235,298

<=2> GET 1st DRAWING SHEET OF 2

Aug. 10, 1993

Temperature compensated stripline filter for microwaves

INVENTOR: Banno, Hisao, Nagoya, Japan
Nishiki, Masahiro, Nagoya, Japan

SUM:

... 4,785,271 and Japanese Patent Prepublication No. 62-263702.

With the microwave stripline filter of the abovementioned type, generally, each dielectric ceramic substrate is made of ceramic material such as BaO-TiO₂, BaO-TiO₂-rare earth or the like.

However, there is disadvantage that the commonly used ceramic material has a resonant frequency which is decreased as the temperature is risen because the temperature coefficient of the resonant frequency is of a negative characteristic.

It is therefore an object of the present invention to provide a stripline ...

LEVEL 1 - 26 OF 68 PATENTS

5,188,809

<=2> GET 1st DRAWING SHEET OF 4

Feb. 23, 1993

Method for separating coke from a feed mixture containing zirconium and radioactive materials by flotation process

INVENTOR: Crocker, William A., Salem, Oregon
Haygarth, John C., Corvallis, Oregon
Riesen, Jon A., Albany, Oregon
Peterson, John R., Salem, Oregon

DETDESC:

... radium removal.

b) Sodium sulfate or any other source of soluble sulfate is then added in excess of the concentration of the barium plus radium ion equivalents and any other cations which might combine with the sulfate ions, i.e. calcium, rare earths, or the like. If the solution is cold, it should be heated and a digestion allowed to take place which can range from a fairly short time up to hours or days. The preferred digestion period would be a few hours with ...

LEVEL 1 - 27 OF 68 PATENTS

5,162,298

<=2> GET 1st DRAWING SHEET OF 5

Nov. 10, 1992

Grain boundary junction devices using high T c
superconductors

INVENTOR: Chaudhari, Praveen, Briarcliff Manor, New York
Chi, Cheng-Chung J., Yorktown Heights, New York
Dimos, Duane B., Upper Montclair, New Jersey
Mannhart, Jochen D., Metzingen, New York, Federal Republic of Germany
Tsuei, Chang C., Chappaqua, New York

SUM:

... as well as to understand the basic mechanisms for superconductivity in this class of materials.

Bednorz and Mueller first showed superconducting behavior in mixed copper-oxides, typically including rare earth and/or rare earth-like elements and alkaline earth elements, for example La, Ba, Sr, . . . , and having a perovskite-like structure. Materials including the so called "1-2-3" phase in the Y-Ba-Cu-O ...

... excess of about 30o K. are generally known as "high T c superconductors", and will be referred to in that manner throughout the specification. This designation is meant to include both the materials having rare earth or rare earth-like elements in their crystalline structure, as well as the more recently reported materials which do not contain rare earth or rare earth-like elements. Generally, all these materials are copper oxide based superconductors having Cu-O planes that appear to be primarily responsible for carrying the supercurrents, where the copper oxide planes are separate or in groups separated by the ...

... [*4] copper oxide material having a superconducting onset temperature greater than 77 K.

[*5] 5. The device of claim 4, where said superconducting material includes an atom selected from the group consisting of rare earth atoms and rare earth-like atoms.

[*6] 6. The device of claim 4, where said superconducting material includes an alkaline earth atoms.

[*7] 7. The device of claim 4, where said superconducting material includes bismuth.

[*8] 8. The device of claim 1, where ...
LEVEL 1 - 28 OF 68 PATENTS

5,160,482

<=2> GET 1st DRAWING SHEET OF 8

Nov. 3, 1992

Zirconium-hafnium separation and purification process

INVENTOR: Ash, Kenneth C., Corvallis, Oregon
Crocker, William A., Salem, Oregon
Haygarth, John C., Corvallis, Oregon
Lee, David R., Lebanon, Oregon
Morris, Donald, Corvallis, Oregon
Peterson, John R., Salem, Oregon
Riesen, Jon A., Albany, Oregon
Yih, Robert S., Salem, Oregon

DETDESC:

... system or solution.

b) Sodium sulfate or any other source of soluble sulfate is then added in excess of the concentration of the barium plus radium ion equivalents and any other cations which might combine with the sulfate ions, i.e. calcium, rare earths, or the like. If the solution is cold, it should be heated and a digestion allowed to take place which can range from a fairly short time up to hours or days. The preferred digestion period would be a few hours with ...

LEVEL 1 - 29 OF 68 PATENTS

5,112,795

May 12, 1992

Supported silver catalyst, and processes for making and using same

INVENTOR: Minahan, David M., Cross Lanes, West Virginia
Thorsteinson, Erlind M., Charleston, West Virginia
Liu, Albert C., Charleston, West Virginia

SUM:

... metal promoter employed is not critical and may include the one or more alkali metals; one or more alkaline earth metals; or one or more other promoters, such as thallium, gold, tin, antimony, rare earths and the like. The catalysts produced are said to be equally as efficient as catalysts produced by coincidental methods of preparation.

Supported, silver-containing, alkylene oxide catalysts often include one or more metal- ...

LEVEL 1 - 30 OF 68 PATENTS

5,084,684

<=2> GET 1st DRAWING SHEET OF 5

Jan. 28, 1992

Method of adjusting a frequency response in a three-conductor type filter device

INVENTOR: Shimizu, Hiroyuki, Nagoya, Japan
Ito, Kenji, Nagoya, Japan
Wakita, Naomasa, Nagoya, Japan

SUM:

... each other. Each of the dielectric substrates 1 and 2 may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 1 is provided with an external ground conducting layer 3 on the peripheral portion and bottom surface thereof. Similarly, the upper dielectric substrate 2 is provided with an external ground conducting layer 4 on the ...

DETDESC:

... assembling of the filter. Each of the dielectric substrates 11 and 12 may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 11 is provided with a ground conducting layer 13 on the lower or outer surface thereof. Similarly, the upper dielectric substrate 12 is provided with a ground conducting layer 14 on the upper or ...

LEVEL 1 - 31 OF 68 PATENTS

5,084,312

A14

Jan. 28, 1992

Molten metal containment vessel with rare earth oxysulfide protective coating thereon and method of making same

INVENTOR: Krikorian, Oscar H., Danville, California
Curtis, Paul G., Tracy, California

SUM:

... same. More particularly, this invention relates to an improved containment vessel for molten metals formed by coating at least the inside surface of a containment vessel with an oxysulfide or sulfide of a rare earth or rare earth-like element.

Molten metals such as uranium, plutonium, aluminum, and calcium are usually contained in vessels or crucibles made from graphite or a refractory metal such as, for example, niobium, tantalum, molybdenum, or tungsten. ...

... in which wetting of the vessel's surfaces by molten metal is inhibited by coating the surfaces of at least the inner walls of the containment vessel with one or more compounds comprising an oxysulfide of a rare earth or a rare earth-like element to inhibit such wetting and/or adherence by the molten metal.

It is a further object of this invention to provide a method for making an improved molten metal containment vessel in which wetting of the surfaces by ...

DETDESC:

... rare earth oxysulfide or sulfide compound include the lanthanide elements La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu; as well as the rare earth-like elements Sc and Y; and actinides such as Th and U. The term "rare earth" and "rare earth elements", as used herein, are therefore intended to define any of the above listed elements.

The rare earth oxysulfide and sulfide coatings of the ...
LEVEL 1 - 32 OF 68 PATENTS

5,075,653

Dec. 24, 1991

Method of adjusting a frequency response in a three-conductor type filter device

INVENTOR: Ito, Kenji, Nagoya, Japan
Shimizu, Hiroyuki, Nagoya, Japan

SUM:

... each other. Each of the dielectric substrates 1 and 2 may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 1 is provided with an external ground conducting layer 3 on the peripheral portion and bottom surface thereof. Similarly, the upper dielectric substrate 2 is provided with an external ground conducting layer 4 on the ...

DETDESC:

... assembling of the filter. Each of the dielectric substrates 11 and 12 may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 11 is provided with an external ground conducting layer 13 on the peripheral portion and outer surface thereof. Similarly, the upper dielectric substrate 12 is provided with an external ground conducting layer 14 on the ...

LEVEL 1 - 33 OF 68 PATENTS

5,066,934

<=2> GET 1st DRAWING SHEET OF 6

Nov. 19, 1991

Method of adjusting a frequency response in a stripline filter device

INVENTOR: Ito, Kenji, Nagoya, Japan
Shimizu, Hiroyuki, Nagoya, Japan
Wakita, Naomasa, Nagoya, Japan

SUM:

... each other. Each of the dielectric substrates 1 and 2 may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 1 is provided with an external ground conducting layer 3 on the peripheral portion and bottom surface thereof. Similarly, the upper dielectric substrate 2 is provided with an external ground conducting layer 4 on the ...

DETDESC:

... assembling of the filter. Each of the dielectric substrates 11 and 12 may be of dielectric ceramic material having a high dielectric constant and a lower dielectric loss such as BaO-TiO₂, BaO-TiO₂-rare earth or the like. The lower dielectric substrate 11 is provided with an external ground conducting layer 13 on the peripheral portion and outer surface thereof. Similarly, the upper dielectric substrate 12 is provided with an external ground conducting layer 14 on the ...

LEVEL 1 - 34 OF 68 PATENTS

5,045,289

<=2> GET 1st DRAWING SHEET OF 4

Sep. 3, 1991

Formation of rare earth carbonates using supercritical carbon dioxide

INVENTOR: Fernando, Quintus, Tucson, Arizona
Yanagihara, Naohisa, Zacopan, New Mexico, Mexico
Dyke, James T., Santa Fe, New Mexico
Vemulapalli, Krishna, Tucson, Arizona

SUM:

... invention. This technique finds use in facilitating the extraction of these materials from rare earth containing mineral ores by providing a scheme for separating these particular rare earths from other rare earth and rare earth-like materials which do not react to form carbonates.

2. Description of the Prior Art

The rare earths, also known as the lanthanides or as lanthanons, and meaning here those elements having atomic numbers 57 to 71, are substances finding utility ...

DETDESC:

... synthesis of rare earth carbonates from certain select rare earths in the trivalent (+3) state as normally found in, for example, rare earth oxides or hydroxides, from other rare earths or rare earth-like materials. Rare earth-like materials are those compounds associated with, normally present in, or formed during the processing of, the various source ores from which the lanthanides are derived. These materials, while not true rare earths are analogous to the lanthanides in structure and behavior and are therefore of concern during processing and separation. Included among these rare earth-like

materials are compounds formed from the actinides, (elements of atomic numbers 89 to 103, such as thorium), titanium, yttrium, and zirconium. In general, these elements, which form the rare earth-like compounds, are present in their + 4 oxidation state; examples include ThO₂ and ZrO₂. The process of the invention has utility in the quantitative precipitation of the particular reactive lanthanides in the + 3 oxidation state and in the separation of these ...

... about 400 C. High yields of 95% or better are obtained in approximately one hour. These particular rare earth oxides or hydroxides can thus be readily separated from the oxides or hydroxides of rare earth or rare earth-like elements such as praseodymium (Pr), terbium (Tb), erbium (Er), ytterbium (Yb), zirconium (Zr), cerium (Ce), and thorium (Th) because these latter rare earth and rare earth-like oxides (or hydroxides) do not form carbonates under the above conditions despite the fact that some are in the trivalent state. It is believed that the oxides of these elements are particularly complex and as such do not readily react under the conditions of the invention.

This ...

Pat. No. 5045289, *

... through appropriate valves and the reaction solution is then filtered. The solids which remain are then washed with deionized water and dried in air. These solids comprise both the rare earth materials which have reacted to form carbonates and also those rare earth and/or rare earth-like materials which did not react, or did not react significantly, and have thus remained in their oxide or hydroxide form.

The solid precipitate obtained above is next treated with a dilute acid such as HCl in a concentration of between 0.1 and 3.0M. Preferably 0.5M HCl is used at ambient temperature and pressure. This acid treatment solubilizes the rare earth carbonates, leaving the unreacted rare earth and rare earth-like oxides and/or hydroxides behind in their solid form. The resultant solution is filtered and the carbonate fraction can be further broken down into individual rare earth carbonates by techniques such as ion exchange or ...

... La₂O₃(49.72%), Nd₂O₃(20.02%), Tb₄O₇(5.08%), Yb₂O₃(5.10%) and ThO₂(20.07%), a high degree of separation of La and Nd was obtained--namely, between 94.3% and 99.8%. Notably, the other rare earth or rare earth-like oxides in this mixture are among those which do not react to form carbonates with supercritical carbon dioxide or by the process of the invention.

The following example will illustrate and describe without limiting the invention. The example illustrates the carbonation process of the invention using essentially pure rare earth oxides.

EXAMPLE

Synthesis of Lanthanide Carbonates

The oxides of the following rare earths and rare earth-like materials, La₂O₃, CeO₂, Pr₆O₁₁, Nd₂O₃, Sm₂O₃, Eu₂O₃, Gd₂O₃, Tb₄O₇, Dy₂O₃, Ho₂O₃, Er₂O₃, Yb₂O₃ and ZrO₂, were obtained from Alfa Division, Danvers, MA, and were 99.9% pure. The carbon dioxide used in this ...

LEVEL 1 - 35 OF 68 PATENTS

4,977,937

<=2> GET 1st DRAWING SHEET OF 4

Dec. 18, 1990

Multiple angle jointer and planer knives

INVENTOR: Hessenthaler, George D., 585 W. 3900 South, #6, Murray, Utah 84123

DETDESC:

... gibe or locking bars, not shown, are tightened, the blade magnets 53 are selected to attract even minimally magnetic material, such as carbide. To provide such magnetic attraction the selected magnets should be very strong,

such as rare earth, or like magnets.

Like the jointer jig 40, a planer jig 60, shown in FIGS. 9 and 10 also utilizes magnets for maintaining blade positioning in a cylindrical cutterhead
61 ...

PAG

LEVEL 1 - 36 OF 68 PATENTS

4,962,086

<=2> GET 1st DRAWING SHEET OF 2

Oct. 9, 1990

High T c superconductor - gallate crystal structures

INVENTOR: Gallagher, William J., Ardsley, New York

Giess, Edward A., Purdys, New York

Gupta, Aranava, Valley Cottage, New York

Laibowitz, Robert B., Peekskill, New York

O'Sullivan, Eugene J., Peekskill, New York

Sandstrom, Robert L., Chappaqua, New York

ABST:

High T c oxide superconductive films can be formed on gallate layers, where the gallate layers include a rare earth element or a rare earth-like element. Combinations of rare earth elements and rare earth-like elements can also be utilized. The superconductive films can be epitaxially deposited on these gallate layers to form single crystals or, in the minimum, highly oriented superconductive layers. Any high T c superconductive ...

SUM:

... materials having Cu-O planes therein which are responsible for carrying supercurrents in these materials. Epitaxial films of these high T c superconductors can be deposited on gallate substrates, where the substrates are rare earth gallates or rare earth-like gallates. These superconductor-substrate combinations are particularly suited for analog and digital signal processing devices including matched filters, correlators, Fourier transformers, spectrum analyzers, samplers, A/D converters, etc.

...

... high T c superconductors.

The high T c superconductors used with these gallate substrates are preferably those which include Cu-O and Cu-O like current carrying planes and can include rare earth and rare earth-like elements, as well as combinations of these elements. Also included are the non-rare earth high T c superconductors such as those having Bi-Sr-Ca-Cu-O compositions and Tl-Ba-Ca-Cu- ...

... less than that when copper containing oxide superconductors are used. Lattice matching of the superconductor atomic spacing to the Ga-O plane is especially good with the copper oxide superconductors which form unique combinations with these gallates.

These rare earth and rare earth-like gallate substrates can be prepared in high quality crystal form and provide excellent lattice matches to the Cu-O based superconducting perovskites. This is important in device applications since for ...

DRWDESC:

BRIEF DESCRIPTION OF THE DRAWINGS

Pat. No. 4962086, *

FIG. 1 illustrates a high T c superconducting film epitaxially deposited on a rare earth or rare earth-like gallate substrate.

FIG. 2 illustrates a structure including a high T c superconducting strip

A18

line surrounded by a gallate lattice-matched insulator, and further including high ...

DETDESC:

... 10 has been deposited on the crystal substrate 12. A cooling means, if needed, is not shown but is well known in the art.

Substrate 12 is a gallate substrate comprised of a rare earth or rare earth-like element, gallium, and oxygen. Examples include LaGaO₃ and NdGaO₃. A mixed gallate can also be used, such as one prepared from La-Y solid solutions. This technique is used to provide different lattice ...

... for use in the substrate include elements 58-71 of the periodic table, and in particular, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu. The rare earth-like elements suitable for use in the gallate substrates include Y, La, Bi and Sc. As noted, combinations of these rare earth and rare earth-like elements can also be used.

For the copper oxide superconductors the rare earth elements Tb, Dy, Ho, Er, Tm, Yb, and Lu may not provide atomic spacings that give lattice ...

... one which in preferred form is characterized by Cu-O planes that are primarily responsible for carrying the supercurrents in these materials. They generally have a perovskite-related structure and can include rare earth and/or rare earth-like elements. These materials often include alkaline earth elements, as for example Ca, Ba, Sr, Mg, . . . An example of a 92° K. superconductor is the well known YBa₂Cu₃O_{7-x}, which is the so-called " ...

... be difficult to stabilize the approximately 110° K. superconducting phase of Bi-Sr-Ca-Cu-O superconductors. However, a favorable epitaxial substrate chosen from the class of gallates including a rare earth or rare earth-like element may aid in stabilizing this and other high T_c phases. A cut along the [110] orthorhombic unit cell of GdGaO₃ would expose a surface with a favorable lattice match which ...

... While the unit cell of this superconducting thin film is rotated 45° with respect to the unit cell of the perovskite substrate, such rotation will not be needed for epitaxial matches of different superconductors to the rare earth and rare earth-like gallate substrates. One of skill in the art would use an orientation of the substrate such that good epitaxy and lattice matching will occur with the chosen superconducting film. In this example, the a and b axes are in the plane of the ...

... approximates a (100) cubic perovskite surface. With this as a guide, the substrate boule material is cut to provide the desired orientation.

It has been noted that the gallate substrates including a rare earth element or a rare earth-like element exhibit good hardness and tolerance to high temperatures. However, it may be preferable to process the superconducting film at temperatures less than the rhombohedral-orthorhombic transition of the substrate in order to maintain the slight orthorhombicity of the substrate.

Pat. No. 4962086, *

...

... Lett. 58, 2684 (1987).

In the practice of this invention, highly oriented films of high T_c oxide superconductors have been deposited on gallate substrates. These substrates are those which include at least one rare earth element or rare earth-like element. The superconducting epitaxial films are highly oriented and can approximate single crystals.

In the further practice of this invention, these high T_c oxide superconducting film-gallate substrate combinations are particularly suitable

...

... apparent to those of skill in the art that variations can be made therein without departing from the spirit and scope of the present invention. For example, the gallate substrate materials may include combinations of rare earth elements and rare earth-like elements, and may also be doped to slightly vary lattice parameters. Further, the superconductive films deposited on these substrates, while preferably being copper oxide-based superconductors, can include rare earth elements, rare earth-like elements, and alkaline earth elements. Still further, combinations of these elements may be present and, also, rare earth elements need not be present in the superconducting film.

The best epitaxial matches occur when the ...
LEVEL 1 - 37 OF 68 PATENTS

4,882,718

<=2> GET 1st DRAWING SHEET OF 3

Nov. 21, 1989

Single-head, direct overwrite magneto-optic system and method

INVENTOR: Kryder, Mark H., Pittsburgh, Pennsylvania
Shieh, Han-Ping D., Pittsburgh, Pennsylvania

DETDESC:

... domain will realign and not grow. Ferrimagnetic alloys including light rare earths such as gadolinium usually provide good mobility but generally require an approximately equal proportion of a heavy rare earth like terbium to increase coercivity to an effective operating level.

A preferred formulation (in atomic %) tested in the laboratory is as follows:

Gd13 Tb13 Fe59 Co15 having a compensation temperature of 90° ...
LEVEL 1 - 38 OF 68 PATENTS

4,882,067

<=2> GET 1st DRAWING SHEET OF 1

Nov. 21, 1989

Process for the chemical bonding of heavy metals from sludge in the silicate structure of clays and shales and the manufacture of building and construction materials therewith

INVENTOR: Johnson, Barrett, Sunnyvale, California
Rubenstein, Charles B., Los Gatos, California

DETDESC:

... containing heavy metals which are generally considered to be toxic to humans and animal life, including arsenic, cobalt, cadmium, chromium, lead, nickel, selenium, thallium, zinc, magnesium, copper, antimony, barium, molybdenum, rare earths and the like and incidental organic toxins. In general, the invented process comprises a batch or continuous operation for the processing of industrial waste and contaminated water. The process developed as described in this patent is not ...

LEVEL 1 - 39 OF 68 PATENTS

4,806,328

Feb. 21, 1989

Method of manufacturing monolithic glass members

INVENTOR: Van Lierop, Joseph G., Eindhoven, Netherlands
Bogemann, Arnoldus B. M., Eindhoven, Netherlands

Felder, Willy J. B., Vijlen, Netherlands
Huizing, Albert, Eindhoven, Netherlands

SUM:

... example, to adjust the refractive index of the glass member obtained after densification of the gel at a given value and/or to control other physical properties. Examples of such compounds are alkoxy compounds of aluminium, titanium, boron, germanium, rare earths and the like, of which the alkoxy groups each generally do not comprise more than 4 carbon atoms. Nitrates, carbonates, acetates and other compounds which decompose easily while forming oxides, may optionally also be used. Fluorine ...

LEVEL 1 - 40 OF 68 PATENTS

4,775,820

<=2> GET 1st DRAWING SHEET OF 3

Oct. 4, 1988

Multilayer electroluminescent device

INVENTOR: Eguchi, Ken, Yokohama, Japan
Kawada, Haruki, Kawasaki, Japan
Nishimura, Yukuo, Sagamihara, Japan

SUM:

... composed of a material of EL function dispersed in a binder.

As the material of EL function, there have been known heretofore inorganic metal materials such as ZnS containing Mn, Cu, ReF₃ (Re: rare earths) or the like as an activating agent, and the like.

In the case of a thin film type EL device, the structure is suitable for the following purposes, that is, a thin luminescent layer can be formed so as to ...

LEVEL 1 - 41 OF 68 PATENTS

4,734,338

<=2> GET 1st DRAWING SHEET OF 3

Mar. 29, 1988

Electroluminescent device

INVENTOR: Eguchi, Ken, Yokohama, Japan
Kawada, Haruki, Kawasaki, Japan
Nishimura, Yukuo, Sagamihara, Japan

SUM:

... layer composed of a material of EL function dispersed in a binder.

As the material of EL function, there have been known heretofore inorganic metal materials such as ZnS containing Mn, Cu, ReF₃ and (Re: rare earths) or the like as an activating agent, and the like.

In the case of a thin film type EL device, the structure is suitable for the following purposes, that is, a thin luminescent layer can be formed so as to ...

PAGE 46

LEVEL 1 - 42 OF 68 PATENTS

4,700,436

<=2> GET 1st DRAWING SHEET OF 4

Oct. 20, 1987

A21

Magnetic fastener

INVENTOR: Morita, Tamao, 47-1, Arakawa 6-Chome, Arakawa-ku, Tokyo, Japan

SUM:

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the utilization of permanent magnets made of hard magnetic powder of ferrite, alnico, rare-earth and the like materials solidified with synthetic resin and then magnetized. More particularly, it relates to an improvement in magnetic material fastener means made of permanent magnet which is provided with magnetic plates at its magnetic poles.

2. Description of the Prior Art

...	PAGE
LEVEL 1 - 43 OF 68 PATENTS	...
4,681,625	...
<=2> GET 1st DRAWING SHEET OF 11	...
Jul. 21, 1987	...

Methods for simultaneously desulfurizing and degassing steels

INVENTOR: Wilson, William G., 820 Harden Dr., Pittsburgh, Pennsylvania 15229

SUM:

... difficult to get into solution and also those whose recoveries from their addition have been less than the amount added to the steel such as electrolytic manganese, ferro-niobium, ferro-tungsten and the like. The metals that may be added include aluminum, calcium, barium, rare earths and the like. The recovery of elements in the steel from additions of metals and ferro-alloys is reduced in many cases in conventional steel making technology by their contact with slags high in oxides such as iron ...

... [*21] metals to be added in the tube to enhance desulfurization are those which are known to have the ability to reduce the oxygen content of the steel, but also have the ability to form sulfides which would float out of the steel into the slag which include magnesium, calcium, barium, rare earths and the like.

[*22] 22. The method as claimed in claims 1 or 5 wherein the ferro-alloys and elemental metals to be added in the tube are those necessary to obtain the desired chemical analysis of the finished steel such as ferro- ...

LEVEL 1 - 44 OF 68 PATENTS

4,598,914

<=2> GET 1st DRAWING SHEET OF 10

Jul. 8, 1986

Sealing and bearing means by use of ferrofluid

INVENTOR: Furumura, Kyozaburo, Ninomiya, Japan
Sugi, Hiromi, Fujisawa, Japan
Murakami, Yasuo, Fujisawa, Japan
Asai, Hiromitsu, Fujisawa, Japan

DETDESC:

... polyamide resin, fluorine resin, polyethersulfone resin, polyphenylene

sulfide resin or the like. The magnetic material to be mixed with the aforesaid synthetic resin material is made of barium-ferrite powder, strontium ferrite powder, rare earths or the like.

The mixture ratio of the synthetic resin and the aforesaid normal magnetic substance is different in case the magnet is used for bearing purposes and sealing purposes.

In case the magnet is employed as bearing, it is to have enough ...
LEVEL 1 - 45 OF 68 PATENTS

4,582,688

<=2> GET 1st DRAWING SHEET OF 1

Apr. 15, 1986

Process for recovery of mineral values

INVENTOR: Venkatesan, Valadi N., Arlington, Texas

DETDESC:

... present, molybdenum can be selectively leached from the ore utilizing a leaching solution containing sodium bicarbonate and oxygen. Thus, for example, substances such as vanadium, molybdenum, selenium, nickel, copper, uranium, the rare earths and the like may be recovered using the process of the present invention. The main criteria is that at least one of the minerals found in the ore may be solubilized without the solubilization of at least one other mineral.

Thus, the present ...

... part of the uranium is present as a refractory uranium-mineral complex. For example, other minerals found in the form of a uranium-mineral complex, include copper, nickel, thorium, scandium, the rare earths, and the like.

Uranium minerals frequently occur in the highly siliceous rocks and sedimentary deposits, generally as a mixture of the insoluble tetravalent form and the soluble hexavalent form. Uranium is also found in association with the silicates, ...

LEVEL 1 - 46 OF 68 PATENTS

4,570,692

<=2> GET 1st DRAWING SHEET OF 6

Feb. 18, 1986

Methods of pouring metal

INVENTOR: Wilson, William G., 820 Harden Dr., Pittsburgh, Pennsylvania 15229

DETDESC:

... teeming operation and good distribution throughout the entire ingot can be expected. When the stability of the oxides in the slags is high, even the most reactive alloys such as aluminum, titanium, zirconium, magnesium, calcium or rare earths and the like will be transferred to the steel from the slag with maximum retention of the alloying element in the metal being teemed. The addition of these alloys along with these stable oxides that will not react with these alloying elements, the elimination of the flow ...

LEVEL 1 - 47 OF 68 PATENTS

4,491,563

Jan. 1, 1985

Process for deodorizing a paraffinic hydrocarbon feedstock

INVENTOR: Reusser, Robert E., Bartlesville, Oklahoma
Murtha, Timothy P., Bartlesville, Oklahoma
Todd, Elizabeth A., Bartlesville, Oklahoma

DETDESC:

... examples are given to provide a better and more complete disclosure of this invention but should not be interpreted to limit its scope.

EXAMPLE I

This example describes a typical catalyst preparation whereby NiO and a rare earth like CeO is deposited on a support. This general procedure is also described in U.S. Pat. No. 4,217,248 column 7, line 49 to column 8, line 41. Two hundred grams of 13 x ...

LEVEL 1 - 48 OF 68 PATENTS

4,489,042

Dec. 18, 1984

Process for recovery of mineral values from subterranean formations

INVENTOR: Savins, Joseph G., Dallas, Texas
Johnson, Warren F., Dallas, Texas

DETDESC:

... formations. However, it should be clear that the invention is applicable to the solution leaching of other mineral values capable of forming soluble reaction products with leaching solutions. Thus, for example, substances such as vanadium, molybdenum, nickel, copper, the rare earths and the like are recovered using the process of the present invention.

As an illustration, the leach chemistry of a uranium ore body can be described by the following equations using hydrogen peroxide (H₂O₂) as oxidant:

PAGE

...

LEVEL 1 - 49 OF 68 PATENTS

4,486,026

<=2> GET 1st DRAWING SHEET OF 10

Dec. 4, 1984

Sealing and bearing means by use of ferrofluid

INVENTOR: Furumura, Kyozaburo, Ninomiya, Japan
Sugi, Hiromi, Fujisawa, Japan
Murakami, Yasuo, Fujisawa, Japan
Asai, Hiromitsu, Fujisawa, Japan

DETDESC:

... polyamide resin, fluorine resin, polyethersulfone resin, polyphenylene sulfide resin or the like. The magnetic material to be mixed with the aforesaid synthetic resin material is made of barium ferrite powder, strontium ferrite powder, rare earths or the like.

The mixture ratio of the synthetic resin and the aforesaid normal magnetic substance is different in case the magnet is used for bearing purposes and sealing purposes.

In case the magnet is employed as bearing, it is to have enough ...

PAGE 54

LEVEL 1 - 50 OF 68 PATENTS

4,481,437

A 24

Nov. 6, 1984

Variable flux permanent magnets electromagnetic machine

INVENTOR: Parker, Rollin J., Greenville, Michigan

DETDESC:

... cylindrical housing 12 in which is mounted, by any appropriate convenient means, a cylindrical tubular stator 14 comprising high strength permanent magnets such as ceramic, or ceramic rare earth, cobalt-rare earth, or the like [magnets] magnets. Each one of a pair of end cap members 16 and 18 fastened at an end of the housing 12 by bolts or screws 20 supports respectively an end magnet ring 22 an ...

LEVEL 1 - 51 OF 68 PATENTS

4,455,392

Jun. 19, 1984

Process for preparing a supported silver catalyst

INVENTOR: Warner, Glenn H., St. Albans, West Virginia

Bhasin, Madan M., Charleston, West Virginia

Lieberman, Bernard, Kew Gardens, New York

SUM:

... as lithium, sodium, potassium, rubidium and/or cesium; one or more alkaline earth metals, such as, barium, magnesium and strontium; or one or more of the other known promoters, such as thallium, gold, tin, antimony and rare earths; and the like. For purposes of convenience, the catalyst preparation process of the invention is described below in terms of a silver-first method of preparation wherein the promoter is selected from among alkali metals, it being recognized that other promoters of ...

LEVEL 1 - 52 OF 68 PATENTS

4,438,077

Mar. 20, 1984

Two stage selective oxidative leach method to separately recover uranium and refractory uranium-mineral complexes

INVENTOR: Tsui, Tien-Fung, Richardson, Texas

SUM:

... least part of the uranium is present as a refractory uranium-mineral complex. For example, other minerals found in a uranium-mineral complex include copper, nickel, thorium, scandium, the rare earths, and the like.

Uranium minerals frequently occur in the highly siliceous rocks and sedimentary deposits, generally as a mixture of the insoluble tetravalent form and the soluble hexavalent form. Uranium is also found in association with the silicates, ...

LEVEL 1 - 53 OF 68 PATENTS

4,427,236

Jan. 24, 1984

In-situ uranium leaching

INVENTOR: Dotson, Billy J., Grand Prairie, Texas

DETDESC:

A25

... be clear that the invention is applicable to the solution mining of other mineral values capable of forming soluble reaction products with carbonated leaching solutions. Thus, for example, substances such as vanadium, molybdenum, nickel, copper, the rare earths and the like are recovered using the process of the present invention.

Uranium minerals frequently occur in the highly siliceous rocks and sedimentary deposits, generally as a mixture of the insoluble quadrivalent form and the soluble sexivalent form. ...

LEVEL 1 - 54 OF 68 PATENTS

4,419,276

Dec. 6, 1983

Silver catalyst for the manufacture of ethylene oxide and a process for preparing the catalyst

INVENTOR: Bhasin, Madan M., Charleston, West Virginia
Warner, Glenn H., St. Albans, West Virginia

SUM:

... as lithium, sodium, potassium, rubidium and/or cesium; one or more alkaline earth metals, such as, barium, magnesium and strontium; or one or more of the other known promoters, such as thallium, gold, tin, antimony and rare earths; and the like. For purposes of convenience, the catalyst preparation process of the invention is described below in terms of a silver-first method of preparation wherein the promoter is selected from among alkali metals, it being recognized that other promoters of ...

PAGE 59

LEVEL 1 - 55 OF 68 PATENTS

4,405,380

Sep. 20, 1983

High strength, low alloy steel with improved surface and mechanical properties

INVENTOR: Griffith, Cecil B., North Royalton, Ohio
Thomas, Jerry D., North Olmsted, Ohio
Demianczuk, Dionisyj W., Parma, Ohio
Abraham, John K., Broadview Heights, Ohio
Franklin, Joseph E., Medina, Ohio

DETDESC:

... present invention is directed to a steel with carbon in the range of 0.03 to 0.06%, the last being an upper limit which also appears crucial for attainment of so-called auto-sulfide-shape control and thus avoidance of the use of rare earths or the like with their consequent expense and tendency to produce unwanted non-metallic surface inclusions.

The base metal may thus consist of the defined composition, with manganese in the range of 0.2 to 0.6%, very preferably not more than 0.45%, while the ...

PAGE 60

LEVEL 1 - 56 OF 68 PATENTS

4,376,264

<=2> GET 1st DRAWING SHEET OF 6

Mar. 8, 1983

Method of checking the authenticity of papers and physically identifiable paper for use in said method

A26

INVENTOR: Dokter, Hendrik D., Ugchelen, Netherlands
Hilderding, Roelof, Fréderikslaan, Netherlands
Mackor, Adrianus, Hollandsche Rading, Netherlands

SUM:

... be some which show a suitable ESR spectrum, although to the knowledge of the present inventors this has never been investigated. However, a further requirement is that a useful ESR spectrum should be obtained at room temperature. Many compounds of rare earths and the like show a useful ESR spectrum only at low temperatures, such as the temperature of liquid nitrogen, but of course an identification of banknotes and the like is hardly of any practical value, if it cannot be carried out at normal room ...

PAGE 61

LEVEL 1 - 57 OF 68 PATENTS

4,367,163

<=2> GET 1st DRAWING SHEET OF 1

Jan. 4, 1983

Silica-clay complexes

INVENTOR: Pinnavaia, Thomas J., East Lansing, Michigan
Mortland, Max M., East Lansing, Michigan
Endo, Tadashi, East Lansing, Michigan

DETDESC:

... be used as a catalyst support for various catalytically active metals such as a Group VIII metal such as platinum, palladium, nickel, iron or cobalt; molybdenum; tungsten; a rare-earth and the like. Moreover, the intercalated product can be used in admixture with other common adsorbents or matrix materials such as silica, alumina, silica-alumina hydrogel and the like. The catalysts which can be prepared by ...

LEVEL 1 - 58 OF 68 PATENTS

4,358,158

<=2> GET 1st DRAWING SHEET OF 1

Nov. 9, 1982

Solution mining process

INVENTOR: Showalter, William E., Seal Beach, California

DETDESC:

... invention is applicable to the solution mining of other mineral values capable of forming soluble reaction products with the dilute carbonic acid leaching solution. Thus, for example, substances such as vanadium, molybdenum, nickel, copper, the rare earths and the like can be recovered using the process of the present invention.

Uranium minerals frequently occur in the highly siliceous rocks and sedimentary deposits, generally as a mixture of the insoluble quadrivalent form and the soluble ...

LEVEL 1 - 59 OF 68 PATENTS

4,358,157

<=2> GET 1st DRAWING SHEET OF 1

Nov. 9, 1982

Solution mining process

A27

INVENTOR: Showalter, William E., Seal Beach, California

DETDESC:

... invention is applicable to the solution mining of other mineral values capable of forming soluble reaction products with the dilute carbonic acid leaching solution. Thus, for example, substances such as vanadium, molybdenum, nickel, copper, the rare earths and the like can be recovered using the process of the present invention.

Uranium minerals frequently occur in the highly siliceous rocks and sedimentary deposits, generally as a mixture of the insoluble quadrivalent form and the soluble ...

LEVEL 1 - 60 OF 68 PATENTS

4,328,079

<=2> GET 1st DRAWING SHEET OF 1

May 4, 1982

Method for pumping impurities, especially noble gases, from hydrogen or mixtures of hydrogen and its isotopes

INVENTOR: Hemmerich, Johann, Stettnerich, Federal Republic of Germany

DETDESC:

... 2 is adjusted by the fluid within the chamber 13 to the temperature for the desired hydrogen partial pressure. In this variation, the cathodes are formed from hydride-forming metals and alloys, for example, rare earth and rare earth-like metals and binary and ternary alloys of them with the addition of transition metals like iron, nickel, cobalt, etc. Upon formation of the sputtered film 12, hydrogen and its isotopes form hydrides with the film by chemisorption that can ...

LEVEL 1 - 61 OF 68 PATENTS

4,279,668

<=2> GET 1st DRAWING SHEET OF 7

Jul. 21, 1981

Directionally solidified ductile magnetic alloy

INVENTOR: Kurz, Wilfried, Lausanne, California, Switzerland
Glardon, Remi, Berkeley, California

SUM:

... relates to a process for the fabrication of magnetic alloys for permanent magnets and to the magnetic bodies obtained by this process.

More particularly the invention relates to ternary magnetic alloys consisting of rare-earth or rare-earth-like elements, cobalt and at least one metal selected from the group which consists of iron, nickel, aluminum, copper, molybdenum or manganese. Preferably the latter metal phase includes 0.1 to 10% (atomic) of the total alloy as ...

LEVEL 1 - 62 OF 68 PATENTS

4,208,225

<=2> GET 1st DRAWING SHEET OF 6

Jun. 17, 1980

Directionally solidified ductile magnetic alloys
magnetically hardened by precipitation hardening

INVENTOR: Kurz, Wilfried, Lausanne, Switzerland
Glardon, Remi, Corseaux, Switzerland

SUM:

... relates to a process for the fabrication of magnetic alloys for permanent magnets and to the magnetic bodies obtained by this process.

More particularly the invention relates to ternary magnetic alloys consisting of rare-earth or rare earth-like elements, cobalt and at least one metal selected from the group which consists of iron, nickel, aluminum, copper, molybdenum or manganese.

BACKGROUND OF THE INVENTION

Ferromagnetic alloys of the cobalt/rare-earth type have a high energy ...
LEVEL 1 - 63 OF 68 PATENTS

4,105,253

<=2> GET 1st DRAWING SHEET OF 1

Aug. 8, 1978

Process for recovery of mineral values from underground formations

INVENTOR: Showalter, William E., Seal Beach, California

DETDESC:

... be clear that the invention is applicable to the solution mining of other mineral values capable of forming soluble reaction products with carbonated leaching solutions. Thus, for example, substances such as vanadium, molybdenum, nickel, copper, the rare earths and the like are recovered using the process of the present invention.

Uranium minerals frequently occur in the highly siliceous rocks and sedimentary deposits, generally as a mixture of the insoluble quadrivalent form and the soluble sexivalent form. ...

LEVEL 1 - 64 OF 68 PATENTS

4,050,052

<=2> GET 1st DRAWING SHEET OF 1

Sep. 20, 1977

Electrical temperature measuring resistor structure,
particularly for resistance thermometers

INVENTOR: Reichelt, Walter, Hanau, Germany, Federal Republic of
Sauer, Gunter, Maintal, Germany, Federal Republic of

DETDESC:

... temperatures can be applied. This cover layer, shown in FIG. 2 schematically at 3, may consist for example of an epoxy resin, glass, or metal oxides of the group of aluminum, beryllium, thorium, rare earths, or the like. The cover layer 3 may be applied by vapor deposition, dusting, or spraying; its primary characteristics should be to be resistant against thermal and mechanical effects. The cover layer should additionally, preferably, provide ...

LEVEL 1 - 65 OF 68 PATENTS

4,014,706

Mar. 29, 1977

Solid solution ceramic materials

INVENTOR: Waldron, Robert D., Scottsdale, Arizona

SUM:

... dimensions of said structure and all physical and chemical properties of the solution are continuous functions of composition. The lattice symmetry may change within said composition range by uniform distortion of the structure as the composition changes.

Rare earth-like (metallic) elements as used herein means elements of atomic numbers 21, 39, and/or 57-71.

Yttrium earth (metallic) elements as used herein means elements of atomic numbers 39 and/or 64-71.

...

PAGE

LEVEL 1 - 66 OF 68 PATENTS

3,983,077

<=2> GET 1st DRAWING SHEET OF 2

Sep. 28, 1976

Process for making ceramic resistor materials

INVENTOR: Fuller, Peter G., Lakeville, Massachusetts
Stoeckler, Hans A., Woonsocket, Rhode Island

DETDESC:

... invention also typically include additions of silicon oxide or manganese oxide or the like and other dopants typically incorporated in such ceramic compositions include lanthanum, cerium, dysprosium, and praesodymium as well as other rare earths and the like commonly used in ceramic resistor materials of positive temperature coefficient of resistivity. Typically, the ceramic titanate materials produced by the process are provided with stoichiometric or slightly titanium-rich compositions, the compositions preferably having an ...

LEVEL 1 - 67 OF 68 PATENTS

3,896,616

<=2> GET 1st DRAWING SHEET OF 1

Jul. 29, 1975

Process and apparatus

INVENTOR: Keith, Carl D., Summit, New Jersey
Mooney, John J., Wyckoff, New Jersey

DETDESC:

... 0.1 to 1.5%. The catalytic element may contain, with or without the platinum group metals, one or more catalytic materials which may include, for example, chromium, manganese, vanadium, copper, iron, cobalt, nickel, rare earths, and the like.

The relative sizes of the initial and subsequent catalytic elements may be such that their volume ratio, i.e. the superficial volume of the subsequent catalyst to the initial catalyst, including void spaces within the catalytic masses, is often at least about ...

LEVEL 1 - 68 OF 68 PATENTS

3,791,143

<=2> GET 1st DRAWING SHEET OF 1

Feb. 12, 1974

PROCESS AND APPARATUS

INVENTOR: Keith, Carl,D., Summit, New Jersey
Mooney, John J., Wyckoff, New Jersey

DETDESC:

... 1.5 percent. The catalytic element may contain, with or without the platinum group metals, one or more catalytic materials which may include, for example, chromium, manganese, vanadium, copper, iron, cobalt, nickel, rare earths, and the like.

The relative sizes of the initial and subsequent catalytic elements may be such that their volume ratio, i.e., the superficial volume of the subsequent catalyst to the initial catalyst, including void spaces within the catalytic masses, is often at least about ...

* 72 PAGES 1431 LINES JOB 97027 100G6J *

* 5:29 P.M. STARTED 5:30 P.M. ENDED 11/22/97 *

Attachment B

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*****03404*****
LEVEL 1 - 1 OF 4 PATENTS

5,344,815

<=2> GET 1st DRAWING SHEET OF 4

Sep. 6, 1994

Fabrication of high T C superconducting helical resonator
coils

INVENTOR: Su, Sophia R., Weston, Massachusetts
O'Connor, Margaret, Worcester, Massachusetts
Butler, Scott, N. Oxford, Massachusetts

... [*13] oxygen for at least 2 hr.

[*14] 14. A method in accordance with claim 11 wherein said mixture further comprises at least about 3 w/o grain aligned clusters of a like rare earth barium copper oxide superconductor.

[*15] 15. A method in accordance with claim 11 wherein said rare earth

barium copper oxide superconductor is an yttrium barium copper oxide superconductor.

[*16] 16. A ...

LEVEL 1 - 2 OF 4 PATENTS

5,236,091

<=2> GET 1st DRAWING SHEET OF 5

Aug. 17, 1993

Eddy current separator and method of making a rotor

INVENTOR: Kauppila, Raymond, Marquette, Michigan
Nowak, Gregory, Girard, Pennsylvania

... as follows:

[*1] 1. A rotor for an eddy current separator comprising a rotor body having generally cylindrical, outer peripheral surfaces designed to be rotated at a design speed;

plate-like rare earth permanent magnets;

adhesive means attaching said plate-like rare earth permanent magnets to said outer peripheral surfaces of said rotor body at a bond line;

said plate-like rare earth permanent magnets being disposed in longitudinal rows extending from one end of said rotor to the other;

said plate-like rare earth permanent magnets in a particular row having a polarity on their outer end opposite the polarity of an outer end of said plate-like permanent magnets in adjacent rows;

a fiber means ...

... [*3] equal to that of carbon.

[*4] 4. A rotor for an eddy current separator comprising a rotor body having generally cylindrical, outer peripheral surfaces designed to be rotated at a design speed;

plate-like rare earth permanent magnets;

adhesive means attaching said plate-like rare earth permanent magnets to said outer peripheral surfaces of said rotor body at a bond line;

said plate-like rare earth permanent magnets being disposed in longitudinal rows extending from one end of said rotor to the other;

said plate-like rare earth permanent magnets in a particular row having a polarity on their outer end opposite the polarity of an outer end of said plate-like permanent magnets in adjacent rows;

fiber means wrapped ...

... [*7] body having a polygonal outer periphery;

said polygonal outer periphery having a plurality of circumferentially disposed adjacent flat surfaces of equal width extending longitudinally of Pat. No. 5236091, *7

said rotor from end to end thereof;

plate-like rare earth permanent magnets having a width substantially equal to the width of sides of said polygonal outer periphery and attached to said flat

surfaces by adhesive;

said plate-like rare earth permanent magnets extending substantially continuously from end to end of said rotor;

said shell being made of an electrically non-conductive material and adapted to receive said rotor;

a heat shield being ...

LEVEL 1 - 3 OF 4 PATENTS

5,162,298

<=2> GET 1st DRAWING SHEET OF 5

Nov. 10, 1992

Grain boundary junction devices using high T_c
superconductors

INVENTOR: Chaudhari, Praveen, Briarcliff Manor, New York
Chi, Cheng-Chung J., Yorktown Heights, New York
Dimos, Duane B., Upper Montclair, New Jersey
Mannhart, Jochen D., Metzingen, New York, Federal Republic of Germany
Tsuei, Chang C., Chappaqua, New York

... [*4] copper oxide material having a superconducting onset temperature greater than 77 K.

[*5] 5. The device of claim 4, where said superconducting material includes an atom selected from the group consisting of rare earth atoms and rare earth-like atoms.

[*6] 6. The device of claim 4, where said superconducting material includes an alkaline earth atoms.

[*7] 7. The device of claim 4, where said superconducting material includes bismuth.

[*8] 8. The device of claim 1, where ...

LEVEL 1 - 4 OF 4 PATENTS

4,681,625

<=2> GET 1st DRAWING SHEET OF 11

Jul. 21, 1987

Methods for simultaneously desulfurizing and degassing
steels

INVENTOR: Wilson, William G., 820 Harden Dr., Pittsburgh, Pennsylvania 15229

... [*21] metals to be added in the tube to enhance desulfurization are those which are known to have the ability to reduce the oxygen content of the steel, but also have the ability to form sulfides which would float out of the steel into the slag which include magnesium, calcium, barium, rare earths and the like.

[*22] 22. The method as claimed in claims 1 or 5 wherein the ferro-alloys and elemental metals to be added in the tube are those necessary to obtain the desired chemical analysis of the finished steel such as ferro- ...

* 5 PAGES 99 LINES JOB 53156 100G6J *

* 12:52 P.M. STARTED 12:52 P.M. ENDED 11/24/97 *

Attachment C

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*****06089*****
FOCUS - 1 OF 107 PATENTS

5,686,394

<=2> GET 1st DRAWING SHEET OF 1

Nov. 11, 1997

Process for manufacturing a superconducting composite

INVENTOR: Sibata, Kenichiro, Hyogo, Japan
Sasaki, Nobuyuki, Hyogo, Japan
Yazu, Shuji, Hyogo, Japan
Jodai, Tetsuji, Hyogo, Japan

SUM:
... Ho-Cu-O system or Ba-Dy-Cu-O system compound oxide which possess the quasi-perovskite type crystal structure including an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

C1

The abovementioned type superconductors can be prepared from a powder mixture Consisting of oxides and/or carbonates containing constituent elements of said superconductor. The powder mixture may include optionally oxides and/or carbonates of at least ...

FOCUS - 2 OF 107 PATENTS

5,679,980

<=2> GET 1st DRAWING SHEET OF 5

Oct. 21, 1997

Conductive exotic-nitride barrier layer for
high-dielectric-constant material electrodes

INVENTOR: Summerfelt, Scott R., Dallas, Texas

DETDESC:

...

TABLE

...

* * Conductive perovskite like
FOCUS - 3 OF 107 PATENTS

5,665,628

<=2> GET 1st DRAWING SHEET OF 5

Sep. 9, 1997

Method of forming conductive amorphous-nitride barrier layer
for high-dielectric-constant material electrodes

INVENTOR: Summerfelt, Scott R., Dallas, Texas

DETDESC:

...

TABLE

...

* * Conductive perovskite like
FOCUS - 4 OF 107 PATENTS

5,661,112

<=2> GET 1st DRAWING SHEET OF 3

Aug. 26, 1997

Superconductor

INVENTOR: Hatta, Shinichiro, 201-1028, Higashinakafuri-2-chome, Hirakata-shi, Japan

Higashino, Hidetaka, A2-505, 117, Hitotsuyacho, Matsubara-shi, Japan

Hirochi, Kumiko, 22, Keihanhondori-1-chome, Moriguchi-shi, Japan

Adachi, Hideaki, 3-1-505, Mitsuiminamimachi, Neyagawa-shi, Japan

... [*1] film being a transition metal element selected from Pt, Au, Ag, Pd, Ni and Ti the composition A-B-Cu-O of said oxide film being in the form of layered perovskite-like structure.

[*2] 2. A superconductor according to claim 1, wherein an additional metal film is formed on said oxide film, or the oxide films and metal films are laminated alternately to form a multi-layer structure.

[*3] ...

FOCUS - 5 OF 107 PATENTS

C2

Jul. 15, 1997

Chemical vapor deposition process for fabricating layered
superlattice materials

INVENTOR: Paz De Araujo, Carlos A., Colorado Springs, Colorado
 Watanabe, Hitoshi, Tokyo, Japan
 Scott, Michael C., Colorado Springs, Colorado
 Mihara, Takashi, Saitama, Japan

DETDESC:

... Layered superlattice materials may be summarized more generally under the formula: [See Original Patent for Chemical Structure Diagram]

where A1, A2 . . . A represent A-site elements in the perovskite-like structure, which may be elements such as strontium, calcium, barium, bismuth, lead, and others, S1, S2 . . . Sk represent super-lattice generator elements, which usually is bismuth, but can also be materials such as yttrium, scandium, lanthanum, antimony, chromium, thallium, and other elements with a valence of + 3, B1, B2 . . . B1 represent B-site elements in the perovskite-like structure, which may be elements such as titanium, tantalum, hafnium, tungsten, niobium, zirconium, and other elements, and Q represents an anion, which may be elements such as oxygen, chlorine and hybrids of these elements, such ...

... [*14] s2 > . . . Sk[xk]< + sk> B1[y1]< + b1> B2[y2]< + b2 > . . .
 B1[y1]< + b1> Q[z]< - 2>, where A1, A2 . . . Aj represent A-site elements in a perovskite-like structure, S1, S2 . . . Sk represent superlattice generator elements, B1, B2 . . . B1 represent B-site elements in said perovskite-like structure, Q represents an anion, the superscripts indicate valences of the respective elements, the subscripts indicate an average number of atoms of the element in the unit cell, and at least w1 and y1 are non-zero, and wherein said A- . . .

PAG

FOCUS - 6 OF 107 PATENTS

Jul. 15, 1997

Method for manufacturing superconducting ceramics in a magnetic field

INVENTOR: Yamazaki, Shunpei, Tokyo, Japan

SUM:

... 300 K. by a method in which a mixture of chemicals in a suitable composition is compacted and fired. These superconducting ceramics form a quasi-molecular atomic unit in a perovskite-like structure whose unit cell is constructed with one layer in which electrons have essentially one-dimensional motion, whereas a number of crystalline grains are arranged at random with diverse crystalline directions, and therefore the critical current density is . . .

... cm from conventional several millimeters. The breadth and thickness may be more flexibly controlled by skilled persons according to the invention in comparison with the prior art technique.

Superconducting materials are constructed in perovskite-like structures as illustrated in FIG. 1 in accordance with the present invention. The structure comprises copper atoms 2, an intervening copper atom 3, oxygen atoms 5 and 6 surrounding the copper . . .

DRWDESC:
BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram showing the configuration of the perovskite-like molecular structure in accordance with the present invention.

FIGS. 2(A) and 2(B) are top and side sectional views showing an apparatus for manufacturing superconducting ceramics in accordance with the present invention.
FOCUS - 7 OF 107 PATENTS

5,646,094

<=2> GET 1st DRAWING SHEET OF 4

Jul. 8, 1997

Rare earth substituted thallium-based superconductors

INVENTOR: Tallon, Jeffrey Lewis, 3 Marine Drive, York Bay, Eastbourne, New Zealand
Presland, Murray Robert, 4/1 Mahina Bay Road, Mahina Bay, Eastbourne, New Zealand

ABST:

... lanthanide rare earth elements and where $0.3 \leq a, b \leq 0.7$, $0.05 \leq c \leq 1.1, 2 - c \leq d \leq 1.95$, $0.05 \leq e \leq 1$, $1.9 \leq f \leq 2.1$ and $6.5 \leq g \leq 7.5$. These compounds, which are layered perovskite-like oxides, exhibit a high chemical stability, form readily into nearly single phase, do not require adjustment of oxygen stoichiometry after synthesis and compositions may be chosen allowing superconductivity at temperatures ...

SUM:

... for example, do not require adjustment of oxygen stoichiometry after synthesis, and compositions may be chosen allowing superconductivity at temperatures exceeding 100 K.

The novel compounds described herein have the same tetragonal layered perovskite-like structure of the parent compound $Tl0.5Pb0.5CaSr2Cu2O7$ comprising in sequence: a $Tl0.5Pb0.5O$ layer with Tl/Pb occupying square corner-shared sites and oxygen distributed about the face centre; a SrO layer with ...
FOCUS - 8 OF 107 PATENTS

5,626,906

<=2> GET 1st DRAWING SHEET OF 3

May 6, 1997

Electrodes comprising conductive perovskite-seed layers for perovskite dielectrics

INVENTOR: Summerfelt, Scott R., Dallas, Texas
Beratan, Howard R., Dallas, Texas

ABST:

... layer and the conductive oxide layer each comprise the same metal. The metal should be conductive in its metallic state and should remain conductive when partially or fully oxidized. Generally, the perovskite-seed layer has a perovskite or perovskite-like crystal structure and lattice parameters which are similar to the perovskite dielectric layer formed thereon. At a given deposition temperature, the crystal quality and other properties of the perovskite dielectric will generally be enhanced by depositing it on ...

SUM:

... As used herein, the term "high-dielectric-constant" means a dielectric constant greater than about 50 at device operating temperature. As used herein the term "perovskite" means a material with a perovskite or perovskite-like

crystal structure. As used herein the term "dielectric", when used in reference to a perovskite, means a non-conductive perovskite, pyroelectric, ferroelectric, or high-dielectric-constant oxide material. The deposition of a ...

... structure. To facilitate perovskite crystal formation, perovskite dielectrics such as PZT have been deposited on some conductive perovskites such as $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ and $(\text{La}, \text{Sr})\text{Co}_3$. Deposition of PZT on a substrate with a perovskite or perovskite-like crystal structure normally minimizes the formation of the pyrochlore phase and improves the properties of the perovskite dielectric. However, the materials used thus far for the deposition surface have several problems. For example, they typically involve new cations such ...

... layer each comprise the same metal. The metal should be conductive in its metallic state and should remain conductive when partially or fully oxidized, and when in a perovskite. Generally, the perovskite-seed layer has a perovskite or perovskite-like crystal structure and lattice parameters which are similar to the perovskite dielectric layer formed thereon. At a given deposition temperature, the crystal quality and other properties of the perovskite dielectric will generally be enhanced by depositing it on ...

DETDESC:

TABLE

ruthenate seed layer perovskite-like materials
FOCUS - 9 OF 107 PATENTS

5,611,854

Mar. 18, 1997

Seed crystals with improved properties for melt processing superconductors for practical applications

INVENTOR: Veal, Boyd W., Downers Grove, Illinois
Paulikas, Arvydas, Downers Grove, Illinois
Balachandran, Uthamalingam, Hinsdale, Illinois
Zhong, Wei, Chicago, Illinois

DETDESC:

... Although PbTiO_3 is shown in the Table, other perovskites of the form RTiO_3 , when R is La or a rare earth are good candidates. EuTiO_3 has a lattice parameter of 3.897 [Angstrom]. NdGaO_3 , and other perovskite-like oxides with the prototype GdFeO_3 structure should also serve well. NdGaO_3 is available as a commercial substrate material. Others may also be commercially available, particularly LaCrO_3 which has many industrial applications.

Oxides with the GdFeO_3 (...
FOCUS - 10 OF 107 PATENTS

5,602,080

<=2> GET 1st DRAWING SHEET OF 1

Feb. 11, 1997

Method for manufacturing lattice-matched substrates for high-T[c] superconductor films

INVENTOR: Bednorz, Johannes G., Wolfhausen, Switzerland
Mannhart, Jochen D., Thalwil, Switzerland
Mueller, Carl A., Hedingen, Switzerland
Schlom, Darrell G., State College, Pennsylvania

SUM:

... a close match-preferably approaching an ideal match-of the lattice parameters of a substrate-without a buffer layer-to a selected high-T[c

]superconductor material having a perovskite or a perovskite-like crystal structure can be achieved by a method comprising the following steps: Determining the relevant lattice constant or constants of the selected superconductor material; choosing a desired orientation of the superconductor layer to ...

... for the deposition of the superconductor.

One preferred method of the invention for manufacturing a lattice-matched substrate for a film of a selected high-T[C]superconductor material having a perovskite or perovskite-like crystal structure at a selected orientation relative to the film dimensions comprises the steps set forth below.

The preferred method of the invention includes the step of determining a relevant lattice constant or constants of the selected ...

... make the codeposition from separate sources each containing one or more of the materials combined to form the buffer layer.

Preferred substrate component materials include strontium titanate SrTiO₃ and lanthanum aluminate LaAlO₃ for perovskite-like superconductor materials such as YBa₂Cu₃O₇ - delta .

In the following description, a preferred method for manufacturing crystalline substrate material having essentially the same lattice constant as the corresponding lattice constant of a ...

FOCUS - 11 OF 107 PATENTS

5,593,951

<=2> GET 1st DRAWING SHEET OF 4

Jan. 14, 1997

Epitaxy of high T[C]superconductors on silicon

INVENTOR: Himpsel, Franz J., Mt. Kisco, New York

SUM:

... first showed superconducting behavior in mixed copper-oxides, typically including rare earth and/or rare earth-like elements and alkaline earth elements, for example La, Ba, Sr, . . . , and having a perovskite-like structure.

Materials including the so called "1-2-3" phase in the Y-Ba-Cu-O system have been found to exhibit a superconducting transition temperature in excess of 77K.
R. B. ...

FOCUS - 12 OF 107 PATENTS

5,590,053

<=2> GET 1st DRAWING SHEET OF 20

Dec. 31, 1996

Method of determining a space group

INVENTOR: Ito, Tatsuya, Kawasaki, Japan
Kawai, Masahito, Kawasaki, Japan
Yasukawa, Yoshihito, Kawasaki, Japan

DETDESC:

... present invention will be described with reference to FIG. 15 to FIG. 20. Let it be assumed here that a crystal as a target of analysis is one of LaGdSrCuO₄. In the case of investigation into such a perovskite-like copper oxide superconductor, it is an effective technique of investigating a new substance to laminate partial structures to grasp a laminate structure

characteristic of the substance. The structure analysis of the target crystal by this technique will ...

FOCUS - 13 OF 107 PATENTS

5,589,284

<=2> GET 1st DRAWING SHEET OF 3

Dec. 31, 1996

Electrodes comprising conductive perovskite-seed layers for perovskite dielectrics

INVENTOR: Summerfelt, Scott R., Dallas, Texas
Beratan, Howard R., Dallas, Texas

ABST:

... layer and the conductive oxide layer each comprise the same metal. The metal should be conductive in its metallic state and should remain conductive when partially or fully oxidized. Generally, the perovskite-seed layer has a perovskite or perovskite-like crystal structure and lattice parameters which are similar to the perovskite dielectric layer formed thereon. At a given deposition temperature, the crystal quality and other properties of the perovskite dielectric will generally be enhanced by depositing it on ...

SUM:

... As used herein, the term "high-dielectric-constant" means a dielectric constant greater than about 50 at device operating temperature. As used herein the term "perovskite" means a material with a perovskite or perovskite-like crystal structure. As used herein the term "dielectric", when used in reference to a perovskite, means a non-conductive perovskite, pyroelectric, ferroelectric, or high-dielectric-constant oxide material. The deposition of a ...

... structure. To facilitate perovskite crystal formation, perovskite dielectrics such as PZT have been deposited on some conductive perovskite such as YBa₂Cu₃O_{7-x} and (La,Sr)CoO₃. Deposition of PZT on a substrate with a perovskite or perovskite-like crystal structure normally minimizes the formation of the pyrochlore phase and improves the properties of the perovskite dielectric. However, the materials used thus far for the deposition surface have several problems. For example, they typically involve new cations such ...

... layer each comprise the same metal. The metal should be conductive in its metallic state and should remain conductive when partially or fully oxidized, and when in a perovskite. Generally, the perovskite-seed layer has a perovskite or perovskite-like crystal structure and lattice parameters which are similar to the perovskite dielectric layer formed thereon. At a given deposition temperature, the crystal quality and other properties of the perovskite dielectric will generally be enhanced by depositing it on ...

DETDESC:

...

TABLE

ruthenate seed layer perovskites or perovskite-
* * like materials (e.g.

FOCUS - 14 OF 107 PATENTS

5,585,300

<=2> GET 1st DRAWING SHEET OF 5

Dec. 17, 1996

Method of making conductive amorphous-nitride barrier layer for high-dielectric-constant material electrodes

INVENTOR: Summerfelt, Scott R., Dallas, Texas

DETDESC:

TABLE

* * Conductive perovskite like
FOCUS - 15 OF 107 PATENTS

5,583,096

<=2> GET 1st DRAWING SHEET OF 8

Dec. 10, 1996

Superconductive compounds and process for producing said
compounds

INVENTOR: Cavazos, Ramon G., Paseo de la Reforma 403, Primer Piso, Mexico D.F.
06500

DETDESC:

... A. Muller in their article entitled "Possible High Tc Superconductivity in Ba-La-Cu-O System". (Zeitschrift fur Physik B-Condensed Matter 64, 189-193 (1986), reported: "... perovskite-like-mixed valent copper compound. Upon cooling, the samples show a linear decrease in resistivity, then an approximately logarithmic increase, interpreted as a beginning of localization. Finally, an abrupt decrease by ...

FOCUS - 16 OF 107 PATENTS

5,563,331

<=2> GET 1st DRAWING SHEET OF 3

Oct. 8, 1996

Magnetoresistive sensor utilizing a sensor material with a
perovskite-like crystal structure

INVENTOR: Von Helmolt, Rittmar, Erlangen, Federal Republic of Germany
Wecker, Joachim, Roettenbach, Federal Republic of Germany

ABST:

A magnetoresistive sensor may be constructed with material having a perovskite-like crystal structure and an increased magnetoresistive effect. The material is based on the composition $(A_1)[1-x](A_2)[x]MnO[z]$, with A1 (trivalent) selected from Y, La, or a lanthanide, A2 (bivalent) from an alkaline- ...

SUM:

BACKGROUND OF THE INVENTION

The present invention relates to a magnetoresistive sensor with a layer made of a sensor material that possesses a perovskite-like crystal structure and exhibits an increased magnetoresistive effect.

The general structure and operation of magnetoresistive sensors with thin films made of ferromagnetic transition metals are explained further in, for example, the book "Sensors", Vol. ...

... $x]Se$ (cf. "Journal of Applied Physics," Vol. 38, No. 3, Mar. 1, 1967, pp. 959-964). A corresponding effect is also evident in $Nd_{0.5}Pb_{0.5}MnO_3$ crystals; these crystals have a perovskite-like structure (cf. "Physics B," Vol. 155, 1989, pp. 362-365). However, the change in electrical resistance as a function of magnetic induction observed in these material systems is confined to low ...

... occur only to a reduced extent, in a sensor material that is the subject of a German patent application No. P 43 10 318.9 (not previously disclosed).

This material possesses a perovskite-like crystal structure and exhibits an increased magnetoresistive effect. A composition based on $(A1)[1-x](A2)[x]MnO[x]$ is to be selected for the material, such that the trivalent constituent Al at least contains ...

... sensor according to an embodiment of the present invention includes at least two layers, a first layer and a second layer. Each of the first and second layers is made of a sensor material that possesses a perovskite-like crystal structure and exhibits an increased magnetoresistive effect. The sensor material of each of the first and second layers has a composition based on $(A1)[1-x](A2)[x]MnO[z]$, where Al is a trivalent ...

DETDESC:

... indicated can also contain minimal impurities with less than 0.5 atomic percent of each impurity element. Exemplary embodiments for corresponding materials are therefore $La0.67Ba0.33MnO_3$, or $Pr0.5Sr0.5MnO_3$, or $Nd0.33Ca0.67MnO_3$, or $(Dy0.67Mg0.33)(Mn0.8Cu0.2)O_2.9$. All these materials have

Pat. No. 5563331, *

FOCUS

a perovskite-like crystal structure and are characterized by an increased magnetoresistive effect $M[r]$ of, in particular, more than 10%, and preferably more than 50%. The effect is thus considerably greater than in known Cu/Co multilayer systems.

...

... 1557-1559). According to the present invention, corresponding layers of the sensor material are advantageously deposited onto substrates whose respective crystalline unit cell has dimensions matched to the unit cell of the sensor material. Substrate materials that also have a perovskite-like crystal structure are therefore particularly suitable. Corresponding exemplary embodiments are $SrTiO_3$, MgO , $LaAlO_3$, $NdGaO_3$, $MgAl_2O_4$, or Y-stabilized ZrO_2 (abbreviated YSZ). In addition, however, Si substrates that are coated with a special intermediate ...

... [*1] a layer system comprising at least two layers, including:

a first layer; and

a second layer;

wherein each of said first and second layers comprises a sensor material that possesses a perovskite-like crystal structure and exhibits an increased magnetoresistive effect, such that the sensor material of each of said first and second layers has a composition based on $(A1)[1-x](A2)[x]MnO[z]$, wherein Al is a

...

... [*4] similar to said first layer and layers similar to said second layer.

[*5] 5. A magnetoresistive sensor according to claim 2; wherein the layer system is deposited on a substrate made of a material that has a perovskite-like crystal structure.

[*6] 6. A magnetoresistive sensor according to claim 1, wherein the first layer and the second layer have different thicknesses.

[*7] 7. A magnetoresistive sensor according to claim 6, wherein the layer system includes ...

... [*7] similar to said first layer and layers similar to said second layer.

[*8] 8. A magnetoresistive sensor according to claim 6, wherein the layer system is deposited on a substrate made of a material that has a perovskite-like crystal structure.

[*9] 9. A magnetoresistive sensor according to claim 1, wherein the layer system includes more than two layers which alternate between layers similar to said first layer and layers similar to said second layer.

[*10] 10. A magnetoresistive sensor according to claim 9, wherein the layer system is deposited on a substrate made of a material that has a

Pat. No. 5563331, *10

FOCUS

perovskite-like crystal structure.

[*11] 11. A magnetoresistive sensor according to claim 1, wherein the layer system is deposited on a substrate made of a material that has a perovskite-like crystal structure.

[*12] 12. A magnetoresistive sensor according to claim 1, wherein $0.25 </= x </= 0.75$.

[*13] 13. A magnetoresistive sensor according to claim 1, wherein $z = 3$.
FOCUS - 17 OF 107 PATENTS

5,554,585

<=2> GET 1st DRAWING SHEET OF 1

Sep. 10, 1996

Method of forming a superconductor microstrip transmission line

INVENTOR: Simon, Randy W., Long Beach, California
Platt, Christine E., El Segundo, California
Lee, Alfred E., Torrance, California
Lee, Gregory S., West Los Angeles, California

REF-CITED:

... 61(1):28-35 (1973).
Geballe, "Paths to Higher Temperature Superconductors," Science, vol. 259, Mar. 12, 1993, pp. 1550-1551.
Geller, S., et al., "Crystallographic Studies of Perovskite-like Compounds. II. Rare Earth Aluminates," Acta Cryst., 9:1019-1025 (1956).
Geller, S., "Crystallographic Studies of Perovskite-like Compounds. IV. Rare Earth Scandates, Vanadites, Galliates, Orthochromites," Acta Cryst., 10:243-248 (1957).
Gulyaev,, Yu V., et al., "YBa₂Cu_{30[7 - x]}Films with a High-temperature ...
FOCUS - 18 OF 107 PATENTS

5,552,373

<=2> GET 1st DRAWING SHEET OF 2

Sep. 3, 1996

Josephson junction device comprising high critical temperature crystalline copper superconductive layers

INVENTOR: Agostinelli, John A., Rochester, New York
Mir, Jose M., Webster, New York
Lubberts, Gerrit, Penfield, New York
Chen, Samuel, Penfield, New York

DETDESC:

... can take any convenient form capable of permitting deposition of USCO" thereon as a thin film.

In a specifically preferred form of the invention SUB" is chosen from

materials that themselves exhibit a perovskite or perovskite-like crystal structure. Strontium titanate is an example of a perovskite crystal structure which is specifically preferred for use as a substrate. Lanthanum aluminate (LaAlO₃), lanthanum gallium oxide (LaGaO₃) and potassium tantalate are ...
FOCUS - 19 OF 107 PATENTS

5,527,567

<=2> GET 1st DRAWING SHEET OF 6

Jun. 18, 1996

Metalorganic chemical vapor deposition of layered structure oxides

INVENTOR: Desu, Seshu B., Blacksburg, Virginia
Tao, Wei, Blacksburg, Virginia
Peng, Chien H., Blacksburg, Virginia
Li, Tingkai, Blacksburg, Virginia
Zhu, Yongfei, Blacksburg, Virginia

SUM:

... 1961), 695; G. A. Smolenski, V. A. Isupov and A. I. Agranovskaya, Fiz Tverdogo Tela, 3, (1961), 895). These compounds have a pseudo-tetragonal symmetry and the structure is comprised of stacking of perovskite-like units between (Bi₂O₂)₂ + layers along the pseudo-tetragonal c-axis. A large number of these compounds do not contain any volatile components in their sublattice that exhibits spontaneous polarization. The tendency for ...

PAGE 22

FOCUS - 20 OF 107 PATENTS

5,523,283

<=2> GET 1st DRAWING SHEET OF 1

Jun. 4, 1996

L[a]AlO₃ Substrate for copper oxide superconductors

INVENTOR: Simon, Randy W., Long Beach, California
Platt, Christine E., El Segundo, California
Lee, Alfred E., Torrance, California
Lee, Gregory S., West Los Angeles, California

REF-CITED:

... 61(1):28-35 (1973).
Gaballe, "Paths to Higher Temperature Superconductors," Science, vol. 259, Mar. 12, 1993, pp. 1550-1551.
Geller, S., et al., "Crystallographic Studies of Perovskite-like Compounds. II. Rare Earth Aluminates," Acta Cryst., 9:1019-1025 (1956).
Geller, S., "Crystallographic Studies of Perovskite-like Compounds. IV. Rare Earth Scandates, Vanadites, Galliates, Orthochromites," Acta Cryst., 10:243-428 (1957).
Gulysev, Yu V., et al., "YBa₂Cu₃O_{7-x}]Films with a High-temperature ...
FOCUS - 21 OF 107 PATENTS

5,523,282

<=2> GET 1st DRAWING SHEET OF 1

Jun. 4, 1996

High-frequency substrate material for thin-film layered perovskite superconductors

INVENTOR: Simon, Randy W., Long Beach, California

C11

Platt, Christine E., El Segundo, California
Lee, Alfred E., Torrance, California
Lee, Gregory S., West Los Angeles, California

REF-CITED:

... A., et al., "The Flux Shuttle-A Josephson Junction Shift Register Employing Single Flux Quanta," Proceedings of the IEEE, 61(1):28-35 (1973).
Geller, S., "Crystallographic Studies of Perovskite-like Compounds. Rare Earth Scandates, Vanadites, Galliates, Orthochromites," Acta Cryst., 10:243-251 (1957).

Gurvitch, M., et al., "Preparation and Substrate Reactions of Superconducting Y-Ba-Cu-O Films," ...

... in the Coprecipitation of Carbonate and Hydroxide Compounds of Lanthanum and Aluminum," Russian Journal of Inorganic Chemistry, vol. 22, No. 11, pp. 1622-1625, 1977.

S. Geller et al., "Crystallographic Studies of Perovskite-like Compounds. II. Rare Earth Aluminates," Acta Cryst., vol. 9, pp. 1019-1025, 1956.

J. Kilner et al., "Electrolytes for the High Temperature Fuel Cell; Experimental and Theoretical ...

FOCUS - 22 OF 107 PATENTS

5,519,234

<=2> GET 1st DRAWING SHEET OF 30

May 21, 1996

Ferroelectric dielectric memory cell can switch at least giga cycles and has low fatigue - has high dielectric constant and low leakage current

INVENTOR: Paz de Araujo, Carlos A., Colorado Springs, Colorado
Cuchiaro, Joseph D., Colorado Springs, Colorado
Scott, Michael C., Colorado Springs, Colorado
McMillan, Larry D., Colorado Springs, Colorado

ABST:

... $s_2 > \dots s_k x_k < + a_k > B_1 y_1 < + b_1 > B_2 y_2 < + b_2 > \dots B_l y_l < + b_l > Q z < - 2 >$, where $A_1, A_2 \dots A_j$ represent A-site elements in a perovskite-like structure, $S_1, S_2 \dots S_k$ represent superlattice generator elements, $B_1, B_2 \dots B_l$ represent B-site elements in a perovskite-like structure, Q represents an anion, the superscripts indicate the valences of the respective elements, the subscripts indicate the number of atoms of the element in the unit cell, and at least w_1 and y_1 are non-zero. Some of these materials are extremely low ...

SUM:

... 676 (1962) and Chapter 8 pages 241-292 and pages 624 & 625 of Appendix F of the Lines and Glass reference cited above. As outlined in section 15.3 of the Smolenskii book, the layered perovskite-like materials can be classified under three general types:

(I) compounds having the formula $A^{m-1} Bi_2 M^m O^{3m+3}$, where $A = Bi < 3 + >$, $Ba < 2 + >$, $Sr < \dots$

... strontium titanates $Sr_2 Ti_4$, $Sr_3 Ti_2 O_7$ and $Sr_4 Ti_3 O_10$; and

(III) compounds having the formula $A^m M^m O^{3m+2}$, including compounds such as $Sr_2 Nb_2 O_7$, $La_2 Ti_2 O_7$, $Sr_5 Ti_2 Nb_4 O_{17}$, and $Sr_6 Ti_2 Nb_4 O_{20}$.

Smolenskii pointed out that the perovskite-like layers may have different thicknesses, depending on the value of m , and that the perovskite AMO_3 is in principal the limiting example of any type of layered perovskite-like structure with $m = \infty$. Smolenskii also noted that if the layer with minimum thickness ($m = 1$) is denoted by P and the bismuth-oxygen layer is denoted by B , then the type I compounds may be described as $\dots BP^m BP^m \dots$. Further

Smolenskii noted that if m is a fractional number then the lattice contains perovskite-like layers of various thicknesses, and that all the known type I compounds are ferroelectrics. Similarly, Smolenskii noted that the type two compounds could be represented as . . . SP_m SP_m . . . where P is the perovskite-like layer of thickness m and S is the strontium-oxygen connecting layer, and that since the type I and type II compounds have similar perovskite-like layers, the existence of "hybrid" compounds such as . . . BP_m SP_n BP_m SP_m . . . "should not be ruled out", though none had been obtained at that time.

Pat. No. 5519234, *

FOCUS

Up to now, these layered ferroelectric . . .

. . . $s_2 > \dots S_k x_k < + s_k > B_1 y_1 < + b_1 > B_2 y_2 < + b_2 > \dots B_l y_l < + b_l > Q z < - 2 >$, where A₁, A₂ . . . A_j represent A-site elements in a perovskite-like structure, S₁, S₂ . . . S_k represent superlattice generator elements, B₁, B₂ . . . B_l represent B-site elements in a perovskite-like structure, Q represents an anion, the superscripts indicate the valences of the respective elements, the subscripts indicate the average number of atoms of the element in the unit cell, and at least w₁ and y₁ are non-zero. Preferably, the A- . . .

. . . layered superlattice material comprises a material having a localized structure, within a grain or other larger or smaller unit, which localized structure contains predominately repeatable units containing one or more perovskite-like layers and one or more intermediate non-perovskite-like layers spontaneously linked in an interdependent manner.

In another aspect the invention provides a non-volatile ferroelectric memory comprising: a ferroelectric memory cell including a layered superlattice . . .

DETDESC:

. . . curves as shown in FIG. 5C, which show fatigue of less than 30%, which is much less than for any ferroelectric material on which endurance tests had been performed in the prior art. It was realized that the SrBi₄Ti₄O₁₅ was one of the layered perovskite-like materials catalogued by Smolenskii, and thought that perhaps the natural layered structure of these materials might be the source of the low-fatigue property. Other devices were fabricated having the structure shown in FIG. 2C, i.e. a . . .

. . . flexible than the lattice of a ferroelectric material. Turning to FIG. 13, a layered superlattice material 92 is illustrated. Smolenskii recognized that what we call the layered superlattice materials spontaneously form into layers 94 with a perovskite-like structure which alternate with layers 96 having a simpler structure. Depending on the material, the perovskite-like layers 94 may include one or a plurality of linked layers of perovskite-like octahedrons 90. As an example, FIG. 14 shows a unit cell of the material ABi₂B₂< + 5 > O₉, which is the formula for strontium bismuth tantalate (SrBi₂Ta₂₀₉) and other layered superlattice materials, such as tantalum, niobium, and tungsten, having a element with a valence of + 5 in the B-site. In this structure, each perovskite-like layer 94 includes two layers of octahedrons 90 which are separated by layers 96 of a material that does not have a perovskite-like structure. In this material the primitive unit cell consists of two perovskite layers 94 and two non-perovskite layers 96, since the structure shifts between the layers 98A and 98B. In FIG. . .

. . . O₁₅, which is the formula for strontium bismuth titanate (SrBi₄Ti₄O₁₅) and other layered superlattice materials having an element, such as titanium, hafnium, and zirconium, having a valence of + 4 in the B-sites. In this material each the perovskite-like layer 94 has four layers of octahedrons 90.

As the understanding of what Smolenskii called a layered perovskite-like structure increased, the inventors have realized that these materials are more than a substance which spontaneously forms in layers. This is seen most easily by an example. Strontium bismuth tantalate (SrBi₂Ta₂₀₉) can be considered to

Pat. No. 5519234, *

be ...

... in the following definition: (B) a material having a localized structure, within a grain or other larger or smaller unit, which localized structure contains predominately repeatable units containing one or more perovskite-like layers and one or more intermediate non-perovskite-like layers spontaneously linked in an interdependent manner.

It has been discovered that the layered superlattice materials catalogued by Smolenskii et al. are all likely candidates for fatigue free switching ferroelectrics and dielectric materials that are resistant to ...

... $x_2 < + s_2 >$. . . $S_k x_k < + s_k >$ $B_1 y_1 < + b_1 >$ $B_2 y_2 < + b_2 >$. . . $B_l y_l < + b_l >$ $Q z < - 2 >$,

where $A_1, A_2 \dots A_j$ represent A-site elements in the perovskite-like structure, which may be elements such as strontium, calcium, barium, bismuth, lead, and others $S_1, S_2 \dots S_k$ represent superlattice generator elements, which usually is bismuth, but can also be materials such as yttrium, scandium, lanthanum, antimony, chromium, thallium, and other elements with a valence of + 3, $B_1, B_2 \dots B_l$ represent B-site elements in the perovskite-like structure, which may be elements such as titanium, tantalum, hafnium, tungsten, niobium, zirconium, and other elements, and Q represents an anion, which generally is oxygen but may also be other elements, such as fluorine, ...

... [$*2$] $s_2 >$. . . $S_k x_k < + s_k >$ $B_1 y_1 < + b_1 >$ $B_2 y_2 < + b_2 >$. . . $B_l y_l < + b_l >$ $Q z < - 2 >$, where $A_1, A_2 \dots A_j$ represent A-site elements in a perovskite-like structure, $S_1, S_2 \dots S_k$ represent superlattice generator elements, $B_1, B_2 \dots B_l$ represent B-site elements in a perovskite-like structure, Q represents an anion, the superscripts indicate the valences of the respective elements, the subscripts indicate the average number of atoms of the element in the unit cell, and at least w_1 and y_1 are non-zero.

[$*3$] 3. A ...

FOCUS - 23 OF 107 PATENTS

5,504,041

<=2> GET 1st DRAWING SHEET OF 5

Apr. 2, 1996

Conductive exotic-nitride barrier layer for
high-dielectric-constant materials

INVENTOR: Summerfelt, Scott R., Dallas, Texas

DETDESC:

...

TABLE

* * Conductive perovskite like materials
FOCUS - 24 OF 107 PATENTS

5,489,548

<=2> GET 1st DRAWING SHEET OF 3

Feb. 6, 1996

Method of forming high-dielectric-constant material
electrodes comprising sidewall spacers

INVENTOR: Nishioka, Yasuhiro, Tsukuba, Texas, Japan
Summerfelt, Scott R., Dallas, Texas

Park, Kyung-Ho, Tsukuba, Japan
Bhattacharya, Pijush, Midnapur, India .

DETDESC:

TABLE

* * Conductive perovskite like
FOCUS - 25 OF 107 PATENTS

5,478,610

<=2> GET 1st DRAWING SHEET OF 5

Dec. 26, 1995

Metalorganic chemical vapor deposition of layered structure
oxides

INVENTOR: Desu, Seshu B., Blacksburg, Virginia
Tao, W., Blacksburg, Virginia

SUM:

... 34, (1961), 695; G. A. Smolenski, V. A. Isupov and A. I. Agranovskaya, Fiz Tverdogo Tela, 3, (1961), 895). These compounds have pseudo-tetragonal symmetry and the structure is comprised of stacking of perovskite-like units between $(Bi_2O_2)_2 + >$ layers along the pseudo-tetragonal c-axis. A large number of these compounds do not contain any volatile components in their sublattice that exhibits spontaneous polarization. The tendency for ...
FOCUS - 26 OF 107 PATENTS

5,468,679

<=2> GET 1st DRAWING SHEET OF 27

Nov. 21, 1995

Process for fabricating materials for ferroelectric, high dielectric constant, and integrated circuit applications

INVENTOR: Paz de Araujo, Carlos A., Colorado Springs, Colorado
Scott, Michael C., Colorado Springs, Colorado
Cuchiaro, Joseph D., Colorado Springs, Colorado
McMillan, Larry D., Colorado Springs, Colorado

SUM:

... 676 (1962) and Chapter 8 pages 241-292 and pages 624 & 625 of Appendix F of the Lines and Glass reference cited above.

As outlined in section 15.3 of the Smolenskii book, the layered perovskite-like materials can be classified under three general types:

(I) compounds having the formula $A^{m-1} Bi_2M^m O^{3m+3}$, where $A = Bi^{3+}$, Ba^{2+} , Sr^{2+} . . .

... $s_2 > \dots S_k x_k < + s_k > B_1 y_1 < + b_1 > B_2 y_2 < + b_2 > \dots B_l y_l < + b_l > Q$
 $z < - 2 >$,

where $A_1, A_2 \dots A_j$ represent A-site elements in a perovskite-like structure, $S_1, S_2 \dots S_k$ represent superlattice generator elements, $B_1, B_2 \dots B_l$ represent B-site elements in a perovskite-like structure, Q represents an anion, the superscripts indicate the valences of the respective elements, the subscripts indicate the average number of atoms of the element in the unit cell, and at least w_1 and y_1 are non-zero. Preferably, the A^- . . .

DETDESC:

... compatible with, or can be designed to be compatible with, the other

materials commonly used in integrated circuits, such as silicon and gallium arsenide.

The class of materials are those disclosed by Smolenskii as having a layered perovskite-like structure, as discussed in the Background of the Invention. It has been realized that these materials are more than a substance which spontaneously forms in layers. This is seen most easily by an example. Strontium bismuth tantalate ($\text{SrBi}_2\text{Ta}_2\text{O}_9$) can ...

... in the following definition: (B) a material having a localized structure, within a grain or other larger or smaller unit, which localized structure contains predominately repeatable units containing one or more perovskite-like layers and one or more intermediate non-perovskite-like layers spontaneously linked in an interdependent manner.

It is well-known that compounds having the perovskite structure may be described in terms of the general formula ABQ_3 , where A and B are cations and Q is an anion. In the ...

Pat. No. 5468679, *

FOCUS

... flexible than the lattice of a ferroelectric material. Turning to FIG. 13, a layered superlattice material 92 is illustrated. Smolenskii recognized that what we call the layered superlattice materials spontaneously form into layers 94 with a perovskite-like structure which alternate with layers 96 having a simpler structure. Depending on the material, the perovskite-like layers 94 may include one or a plurality of linked layers of perovskite-like octahedrons 90. As an example, FIG. 14 shows a unit cell of the material $\text{AB}_2\text{B}_2<+5>\text{O}_9$, which is the formula for strontium bismuth tantalate ($\text{SrBi}_2\text{Ta}_2\text{O}_9$) and other layered superlattice materials, such as tantalum, niobium, and tungsten, having an element with a valence of + 5 in the B-site. In this structure, each perovskite-like layer 94 includes two layers of octahedrons 90 which are separated by layers 96 of a material that does not have a perovskite-like structure. In this material the primitive unit cell consists of two perovskite layers 94 and two non-perovskite layers 96, since the structure shifts between the layers 98A and 98B. In FIG. ...

... 015, which is the formula for strontium bismuth titanate ($\text{SrBi}_4\text{Ti}_4\text{O}_15$) and other layered superlattice materials having an element, such as titanium, hafnium, and zirconium, having a valence of + 4 in the B-sites. In this material each the perovskite-like layer 94 has four layers of octahedrons 90.

It has been discovered that the layered superlattice materials catalogued by Smolenskii et al. are all likely candidates for fatigue free switching ferroelectrics and dielectric materials that are resistant to ...

... $x_2 <+ s_2>$. . . $S_k x_k <+ s_k>$ $B_1 y_1 <+ b_1>$ $B_2 y_2 <+ b_2>$. . . $B_l y_l <b_l>$ $Q z <- 2>$,

where $A_1, A_2 \dots A_j$ represent A-site elements in the perovskite-like structure, which may be elements such as strontium, calcium, barium, bismuth, lead, and others $S_1, S_2 \dots S_k$ represent superlattice generator elements, which usually is bismuth, but can also be materials such as yttrium, scandium, lanthanum, antimony, chromium, thallium, and other elements with a valence of + 3, $B_1, B_2 \dots B_l$ represent B-site elements in the perovskite-like structure, which may be elements such as titanium, tantalum, hafnium, tungsten, niobium, zirconium, and other elements, and Q represents an anion, which generally is oxygen but may also be other elements, such as fluorine, ...

FOCUS - 27 OF 107 PATENTS

5,447,908

<=2> GET 1st DRAWING SHEET OF 1

Sep. 5, 1995

Superconducting thin film and a method for preparing the

C16

same

INVENTOR: Itozaki, Hideo, Hyogo, Japan
Tanaka, Saburo, Hyogo, Japan
Fujita, Nobuhiko, Hyogo, Japan
Yazu, Shuji, Hyogo, Japan
Jodai, Tetsuji, Hyogo, Japan

SUM:

... structure. The term of quasi-perovskite type means a structure which can be considered to have such a crystal structure that is similar to Perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygendeficient perovskite or the like.

The superconducting thin film may be also another type of superconductor consisting mainly of a compound oxide represented by the formula:

THETA 4(PHI 1-q ,Ca q) m Cu ...
FOCUS - 28 OF 107 PATENTS

5,447,906

Sep. 5, 1995

Thin film high TC oxide superconductors and vapor deposition methods for making the same

INVENTOR: Chaudhari, Praveen, Briarcliff Manor, New York
Gambino, Richard J., Yorktown Heights, New York
Koch, Roger H., Amawalk, New York
Lacey, James A., Mahopac, New York
Laibowitz, Robert B., Peekskill, New York
Viggiano, Joseph M., Wappingers Falls, New York

SUM:

... areas.

It is another object of the present invention to provide continuous, smooth copper oxide superconductive films exhibiting superconductivity at temperatures in excess of 40° K. and methods for making these films, where the films exhibit perovskite-like structure.

It is another object of this invention to provide transition metal oxide superconductive films including a rare earth element, or rare earth-like element, where the films exhibit superconductivity at temperatures greater than 40° ...

... earth-like element, B is an alkaline earth element, and y is sufficient to satisfy valence demands of the composition.

It is another object of the present invention to provide smooth, continuous copper oxide superconducting films having a perovskite-like crystal structure and exhibiting superconductivity at temperatures in excess of 40° K., and to provide methods for making these films.

SUMMARY OF THE INVENTION

The films of this invention are oxide superconductors exhibiting superconductivity at temperatures in excess of ...

... addition to being continuous, smooth, and of excellent compositional uniformity. The Cu oxide films are therefore considered to be unique examples of this class of films, as are the processes for making them.

Typically, the films are characterized by a perovskite-like crystalline structure, such as those described in more detail by C. Michel and B. Rayeau in Revue Dde.

5,439,878

<=2> GET 1st DRAWING SHEET OF 21

Aug. 8, 1995

Method for preparing copper oxide superconductor containing
carbonate radicals

INVENTOR: Kinoshita, Kyoichi, Hoya, Japan
Yamada, Tomoaki, Higashimurayama, Japan

SUM:

... novel superconducting material.

Description of the Prior Art

Several types of copper oxide superconductors have been discovered since high-T_c superconductivity was detected in the La-Ba-Cu-O system. Superconductivity would arise from the layered perovskite-like structure having Cu₆ octahedra, or Cu₅ pyramids, or Cu₂ square planes as a building unit. The layered perovskite-like structure and a sufficient carrier concentration of the material are essential factors for making the material superconducting as indicated by Osamura & Zhang (Japan. J.Appl.Phys.26, L2094-L2096, 1987). ...

FOCUS - 30 OF 107 PATENTS

5,439,876

<=2> GET 1st DRAWING SHEET OF 5

Aug. 8, 1995

Method of making artificial layered high T_c superconductors

INVENTOR: Graf, Volker, Wollerau, Switzerland
Mueller, Carl A., Hedingen, Switzerland

DETDESC:

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

One material particularly suited as a substrate in the epitaxial growth of high T_c superconductor material is strontium titanate, SrTiO₃, which forms crystals like perovskite (FIG. 1). Each titanium ion 1 is octahedrally surrounded by six oxygen ions 2, the bigger strontium ions 3 being disposed in the spaces in between. At room temperature, ...

FOCUS - 31 OF 107 PATENTS

5,426,092

<=2> GET 1st DRAWING SHEET OF 14

Jun. 20, 1995

Continuous or semi-continuous laser ablation method for depositing fluorinated superconducting thin film having basal plane alignment of the unit cells deposited on non-lattice-matched substrates

INVENTOR: Ovshinsky, Stanford R., Bloomfield Hills, Michigan
Young, Rosa, Troy, Michigan

SUM:

... growth of a crystalline superconducting material in a manner as if mimicking the orientation of a substrate having an identical lattice structure

without the presence of such a substrate lattice structure. Simply stated, an "epitaxial-like" perovskite superconducting material grown on a non-lattice-matched substrate would nonetheless be characterized by a lattice structure identical to the lattice structure which would be present if the material was grown on a perovskite substrate. Thus, " ...

FOCUS - 32 OF 107 PATENTS

5,424,282

<=2> GET 1st DRAWING SHEET OF 5

Jun. 13, 1995

Process for manufacturing a composite oxide superconducting wire

INVENTOR: Yamamoto, Susumu, Hyogo, Japan
Murai, Teruyuki, Hyogo, Japan
Kawabe, Nozomu, Hyogo, Japan
Awazu, Tomoyuki, Hyogo, Japan
Yazu, Shuji, Hyogo, Japan
Jodai, Tetsuji, Hyogo, Japan

DETDESC:

... term of "quasiperovskite type structure" means any oxide that can be considered to have such a crystal structure—that is similar to perovskite-type oxides and may include an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

In practice, the element α is preferably selected from Ba, Sr and/or Ca and the element β is preferably selected from Y, La and/or lanthanid such as Sc, Ce, Gd, Ho, Er, Tin, Y b, ...

FOCUS - 33 OF 107 PATENTS

5,423,285

<=2> GET 1st DRAWING SHEET OF 27

Jun. 13, 1995

Process for fabricating materials for ferroelectric, high dielectric constant, and integrated circuit applications

INVENTOR: Paz de Araujo, Carlos A., Colorado Springs, Colorado
Cuchiaro, Joseph D., Colorado Springs, Colorado
Scott, Michael C., Colorado Springs, Colorado
McMillan, Larry D., Colorado Springs, Colorado

SUM:

... 676 (1962) and Chapter 8 pages 241-292 and pages 624& 625 of Appendix F of the Lines and Glass reference cited above.

As outlined in section 15.3 of the Smolenskii book, the layered perovskite-like materials can be classified under three general types:

(I) compounds having the formula $A^{m-1} Bi_2 M^{0.3m+3}$, where $A = Bi < 3 + >$, $Ba < 2 + >$, $Sr < ...$

... $s_2 > \dots S_k x_k < + s_k > B_1 y_1 < + b_1 > B_2 y_2 < + b_2 > \dots B_1 y_1 < + b_1 > Q z < - 2 >$, where $A_1, A_2 \dots A_j$ represent A-site elements in a perovskite-like structure, $S_1, S_2 \dots S_k$ represent superlattice generator elements, $B_1, B_2 \dots B_1$ represent B-site elements in a perovskite-like structure, Q represents an anion, the superscripts indicate the valences of the respective elements, the subscripts indicate the average number of atoms of the element in the unit cell, and at least w_1 and y_1 are non-zero. Preferably, the $A^- \dots$

DETDESC:

... compatible with, or can be designed to be compatible with, the other materials commonly used in integrated circuits, such as silicon and gallium arsenide.

The class of materials are those disclosed by Smolenskii as having a layered perovskite-like structure, as discussed in the Background of the Invention. It has been realized that these materials are more than a substance which spontaneously forms in layers. This is seen most easily by an example. Strontium bismuth tantalate ($\text{SrBi}_2\text{Ta}_2\text{O}_9$) can ...

... in the following definition: (B) a material having a localized structure, within a grain or other larger or smaller unit, which localized structure contains predominately repeatable units containing one or more perovskite-like layers and one or more intermediate non-perovskite-like layers spontaneously linked in an interdependent manner.

It is well-known that compounds having the perovskite structure may be described in terms of the general formula ABQ_3 , where A and B are cations and Q is an anion. In the ...

... flexible than the lattice of a ferroelectric material. Turning to FIG. 13, a layered superlattice material 92 is illustrated. Smolenskii recognized Pat. No. 5423285, *

FOCUS

that what we call the layered superlattice materials spontaneously form into layers 94 with a perovskite-like structure which alternate with layers 96 having a simpler structure. Depending on the material, the perovskite-like layers 94 may include one or a plurality of linked layers of perovskite-like octahedrons 90. As an example, FIG. 14 shows a unit cell of the material $\text{AB}_2\text{B}_2<+5>\text{O}_9$, which is the formula for strontium bismuth tantalate ($\text{SrBi}_2\text{Ta}_2\text{O}_9$) and other layered superlattice materials, such as tantalum, niobium, and tungsten, having an element with a valence of + 5 in the B-site. In this structure, each perovskite-like layer 94 includes two layers of octahedrons 90 which are separated by layers 96 of a material that does not have a perovskite-like structure. In this material the primitive unit cell consists of two perovskite layers 94 and two non-perovskite layers 96, since the structure shifts between the layers 98A and 98B. in FIG. ...

... 015, which is the formula for strontium bismuth titanate ($\text{SrBi}_4\text{Ti}_4\text{O}_15$) and other layered superlattice materials having an element, such as titanium, hafnium, and zirconium, having a valence of + 4 in the B-sites. In this material each the perovskite-like layer 94 has four layers of octahedrons 90.

It has been discovered that the layered superlattice materials catalogued by Smolenskii et al. are all likely candidates for fatigue free switching ferroelectrics and dielectric materials that are resistant to ...

... $\text{Sk xk} < + \text{sk} > \text{B1 y1} < + \text{b1} > \text{B2 y2} < + \text{b2} > \dots \text{B1 y1} < + \text{b1} > \text{Q z} < - \text{2} >$, tm (1)

where $A_1, A_2 \dots A_j$ represent A-site elements in the perovskite-like structure, which may be elements such as strontium, calcium, barium, bismuth, lead, and others $S_1, S_2 \dots S_k$ represent superlattice generator elements, which usually is bismuth, but can also be materials such as yttrium, scandium, lanthanum, antimony, chromium, thallium, and other elements with a valence of + 3, $B_1, B_2 \dots B_l$ represent B-site elements in the perovskite-like structure, which may be elements such as titanium, tantalum, hafnium, tungsten, niobium, zirconium, and other elements, and Q represents an anion, which generally is oxygen but may also be other elements, such as fluorine, ...

FOCUS - 34 OF 107 PATENTS

5,409,890

Apr. 25, 1995

Process for producing an elongated sintered article

C 20

INVENTOR: Yamamoto, Susumu, Hyogo, Japan
Kawabe, Nozomu, Hyogo, Japan
Awazu, Tomoyuki, Hyogo, Japan
Murai, Teruyuki, Hyogo, Japan

SUM:

... term quasi-perovskite type means a structure which can be considered to have such a crystal structure that is similar to perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

The sintering operation of the powder mixture is carried out at temperature which is higher than 600°C. but is not higher than the lowest melting point of any component in the material powder to be sintered. If the sintering temperature exceeds the ...

FOCUS - 35 OF 107 PATENTS

5,401,715

<=2> GET 1st DRAWING SHEET OF 1

Mar. 28, 1995

Semiconductor substrate having a superconducting thin film

INVENTOR: Itozaki, Hideo, Hyogo, Japan
Harada, Keizo, Hyogo, Japan
Fujimori, Naoji, Hyogo, Japan
Yazu, Shuji, Hyogo, Japan
Jodai, Tetsuji, Hyogo, Japan

DETDESC:

... term quasi-perovskite type means a structure which can be considered to have such a crystal structure that is similar to perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

An atomic ratio of the lanthanide element "Ln":Ba:Cu is preferably 1:2:3 as is defined by the formula but the atomic ratio is not restricted strictly to this ratio. In fact, the other compound oxides having ...

FOCUS - 36 OF 107 PATENTS

5,389,603

<=2> GET 1st DRAWING SHEET OF 5

Feb. 14, 1995

Oxide superconductors, and devices and systems comprising such a superconductor

INVENTOR: Batlogg, Bertram J., New Providence, New Jersey
Cava, Robert J., Bridgewater, New Jersey

DETDESC:

... microscopy indicate a basically orthorhombic crystal structure, but there are also indications that, at least for some of the inventive compounds, the structure may be weakly monoclinic. Both of these possibilities are intended to be included in the term "perovskite-like" or analogous terms. Diffraction studies have also revealed the presence of a variety of long period long range ordered superlattices (typically in the ab plane).

FIG. 2 shows the field (225 Oe)-cooled ...

We claim:

C 21

[*1] 1. An article comprising a superconductive element comprising at least one superconductive material having a perovskite-like crystal structure and nominal formula $(Pb_2A_2Cu')BCu_2O_8 + \delta$ with (A selected from the group consisting of Sr, Ba, Sr and Ba, Sr and Ca, and Sr, Ba and Ca; Cu' is selected from the group consisting of ...

... [*1] parallel to the ab-plane; and wherein the composition is selected such that the superconductive material has a transition temperature of at least about 30K.

[*2] 2. An article comprising a superconductive element comprising at least one superconductive material having a perovskite-like crystal structure and nominal formula $(X_2A_2Cu')BCu_2O_8 + \delta$, where X is selected from the group consisting of Pb, Pb and Bi, Pb and Tl, and Pb, Bi and Tl, with X being at least 50 atomic % of ...

FOCUS - 37 OF 107 PATENTS

5,362,710

<=2> GET 1st DRAWING SHEET OF 2

Nov. 8, 1994

Process for preparing high Tc superconducting material

INVENTOR: Fujita, Nobuhiko, Hyogo, Japan
Kobayashi, Tadakazu, Hyogo, Japan
Itozaki, Hideo, Hyogo, Japan
Tanaka, Saburo, Hyogo, Japan
Yazu, Shuji, Hyogo, Japan
Jodai, Tetsuji, Hyogo, Japan

SUM:

... quasi-perovskite type oxide means a structure which can be considered to have such a crystal structure that is similar to perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

The present invention also provides a process for producing the abovementioned superconducting material, characterized by sintering a mixture of the following powders:

an oxide, carbonate, nitrate or sulfate of one element "A" selected from ...
FOCUS - 38 OF 107 PATENTS

5,356,674

<=2> GET 1st DRAWING SHEET OF 2

Oct. 18, 1994

Process for applying ceramic coatings using a plasma jet carrying a free form non-metallic element

INVENTOR: Henne, Rudolf, Boeblingen, Federal Republic of Germany
Weber, Winfried, Leinfelden-Echterdingen, Federal Republic of Germany
Schiller, Guenter, Gerlingen, Federal Republic of Germany
Schnurnberger, Werner, Stuttgart, Federal Republic of Germany
Kabs, Michael, Hanau, Federal Republic of Germany

SUM:

... materials are oxidized materials, for example, spinels and perovskites on a nickel or cobalt or nickel-cobalt basis. It is, however, also conceivable to apply all possible kinds of spinels and perovskites in accordance with the inventive process. This also applies to spinel-like and perovskite-like compounds and to non oxidized compounds, for example, nitrides, halides, carbides, etc., with nitrogen or halogens or also non-metallic compounds,

methane or acetylene then being carried along as non-metallic element by the ...
FOCUS - 39 OF 107 PATENTS

5,354,733

<=2> GET 1st DRAWING SHEET OF 21

Oct. 11, 1994

Copper oxide superconductor containing carbonate radicals

INVENTOR: Kinoshita, Kyoichi, Hoya, Japan
Yamada, Tomoaki, Higashimurayama, Japan

SUM:

... 2. Description of the Prior Art

Several types of copper oxide superconductors have been discovered since high-T_c superconductivity was detected in the La-Ba-Cu-O system. Superconductivity would arise from the layered perovskite-like structure having Cu₆ octahedra, or Cu₅ pyramids, or Cu₂O square planes as a building unit. The layered perovskite-like structure and a sufficient carrier concentration of the material are essential factors for making the material superconducting as indicated by Osamura & Zhang (Japan.J.Appl.Phys.26, L2094-L2096, 1987). ...

FOCUS - 40 OF 107 PATENTS

5,340,796

<=2> GET 1st DRAWING SHEET OF 5

Aug. 23, 1994

Oxide superconductor comprising Cu, Bi, Ca and Sr

INVENTOR: Cava, Robert J., Bridgewater, New Jersey
Sunshine, Steven A., Berkeley Heights, New Jersey

ABST:

Novel superconductive oxides are disclosed. The oxides all have layered perovskite-like crystal structure and manifest superconductivity above about 77K. An exemplary material has composition Bi_{2.2}Sr₂Ca_{0.8}Cu₂O₈. Other materials are described by the nominal formula X₂ + x M_n - x Cu_n - ...

SUM:

... high temperature superconductors has been reported since publication of the above seminal papers. Most of the work deals with YBa₂Cu₃O_x (the so-called 1-2-3 compound) and related compounds.

In all of these compounds the superconducting phase is perovskite-like, typically having orthorhombic crystal structure, and the compounds that exhibit high (i.e., T_c > 77K) temperature superconductivity generally contain one or more rare earth elements.

The discovery of high T_c superconductivity in some ...

... likely to be stable high T_c superconductors, with T_c's likely to be above 100K.

The novel phases all have a crystal structure that is closely related to that of the above described 80K compound and thus are perovskite-like. They differ from each other essentially only in the number of crystal planes between the two Bi-O double planes that bound the unit cell in the c-direction, or by the size of the supercell. The composition of the ...

DETDESC:

... in added layers of M and Cu between the Bi-O double layers and are expected to result in one or more phases of stable high T_c superconductive

material.

All of the inventive phases have layered perovskite-like crystal structure, and the existence of relatively weak bonding between at least some layers may be the cause of the observed relatively high ductility of the inventive materials. It will be appreciated that by "perovskite-like" we mean not only the prototypical, truly cubic structure, but very significantly distortions therefrom.

Material specification in accordance with the invention depends upon the nature of the intended use. For power transmission, or any other currentcarrying

PAGE

Pat. No. 5340796, *

FOCUS

What is claimed is:

[*1] 1. An article comprising material perovskite-like structure and of nominal composition $X_2 + x M_4 - x Cu_{3010} + 0.5 \pm \delta$, where [$x = p/q < 0.4$, and p and q are positive integers] $0 \leq x < 0.4$, X is Bi and Pb, ...

FOCUS - 41 OF 107 PATENTS

5,338,721

<=2> GET 1st DRAWING SHEET OF 5

Aug. 16, 1994

Process for manufacturing a superconducting composite

INVENTOR: Yamamoto, Susumu, Hyogo, Japan

Murai, Teruyuki, Hyogo, Japan

Kawabe, Nozomu, Hyogo, Japan

Awazu, Tomoyuki, Hyogo, Japan

Yazu, Shuji, Hyogo, Japan

Jodai, Tetsuji, Hyogo, Japan

DETDESC:

... quasi-perovskite type structure" means any oxide that can be considered to have such a crystal structure that is similar to perovskite-type oxides and may include an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

In practice, the element alpha is preferably selected from Ba, Sr and/or Ca and the element beta is preferably selected from Y, La and/or lanthanid such as Sc, Ce, Gd, Ho, Er, Tm, Yb, Lu and the ...

FOCUS - 42 OF 107 PATENTS

5,332,722

<=2> GET 1st DRAWING SHEET OF 3

Jul. 26, 1994

Nonvolatile memory element composed of combined superconductor ring and MOSFET

INVENTOR: Fujihira, Mitsuka, Yokohama, Japan

DETDESC:

... term quasi-perovskite type means a structure which can be considered to have such a crystal structure that is similar to perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

Another superconducting compound oxide which can be used by the present invention is represented by the general formula:

(M,Sr)2CuO 4- .delta.

in which M stands for Y or La and ...
FOCUS - 43 OF 107 PATENTS

5,328,892

Jul. 12, 1994

Oxide superconductor composition and a process for the
production thereof

INVENTOR: Manako, Takashi, Tokyo, Japan
Shimakawa, Yuichi, Tokyo, Japan
Kubo, Yoshimi, Tokyo, Japan

SUM:

... following formulae:

TlSr 3 - x Y x Cu207(IA)

wherein $0.1 \leq x \leq 1$, and

TlSr 4 - x Y x Cu309(IB)

wherein $0.1 \leq x \leq 2$. Unit cells of the layered perovskite-like crystal
structures of these compositions of the formulae (IA) and (IB) may be shown
respectively as follows:

Tl0/Sr0/Cu02/Sr or Y/Cu02/Sr0(IX)

Tl0/Sr0/Cu02/Sr or Y/ ...

FOCUS - 44 OF 107 PATENTS

5,296,458

<=2> GET 1st DRAWING SHEET OF 4

Mar. 22, 1994

Epitaxy of high T c superconducting films on (001) silicon
surface

INVENTOR: Himp sel, Franz J., Mt. Kisco, New York

SUM:

... first showed superconducting behavior in mixed copper-oxides, typically
including rare earth and/or rare earth-like elements and alkaline earth
elements, for example La, Ba, Sr, . . . , and having a perovskite-like
structure. Materials including the so called "1-2-3" phase in the Y-Ba-Cu-O
system have been found to exhibit a superconducting transition temperature in
excess of 77K.

R. B. ...

FOCUS - 45 OF 107 PATENTS

5,286,712

<=2> GET 1st DRAWING SHEET OF 2

Feb. 15, 1994

High TC superconducting film

INVENTOR: Fujita, Nobuhiko, Hyogo, Japan
Kobayashi, Tadakazu, Hyogo, Japan

C25

Itozaki, Hideo, Hyogo, Japan
Tanaka, Saburo, Hyogo, Japan
Yazu, Shuji, Hyogo, Japan
Jodai, Tetsuji, Hyogo, Japan

SUM:

... quasi-perovskite type oxide means a structure which can be considered to have such a crystal structure that is similar to perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

The present invention also provides a process for producing the abovementioned superconducting material, characterized by sintering a mixture of the following powders:

an oxide, carbonate, nitrate or sulfate of one element "A" selected from ...
FOCUS - 46 OF 107 PATENTS

5,283,465

<=2> GET 1st DRAWING SHEET OF 5

Feb. 1, 1994

Superconducting lead on integrated circuit

INVENTOR: Yamazaki, Shunpei, Tokyo, Japan

DETDESC:

... subjected to supplemental annealing at 500°-600° C. for 1-2 hours as illustrated in FIG. 1(B). The supplemental annealing allows the superconducting ceramic material to form a modulated perovskite-like structure and, as a result, a high critical temperature is realized. On the substrate, there are provided superconducting leads 10 and 10' for interconnection among devices and contacts formed in or on the semiconductor substrate and a ...

FOCUS - 47 OF 107 PATENTS

5,278,140

<=2> GET 1st DRAWING SHEET OF 5

Jan. 11, 1994

Method for forming grain boundary junction devices using high T c superconductors

INVENTOR: Chaudhari, Praveen, Briarcliff Manor, New York
Chi, Cheng-Chung J., Yorktown Heights, New York
Dimos, Duane B., Montclair, New Jersey
Mannhart, Jochen D., Metzingen, New York, Federal Republic of Germany
Tsuei, Chang C., Chappaqua, New York

SUM:

... first showed superconducting behavior in mixed copper-oxides, typically including rare earth and/or rare earth-like elements and alkaline earth elements, for example La, Ba, Sr, . . . , and having a perovskite-like structure. Materials including the so called "1-2-3" phase in the Y-Ba-Cu-O system have been found to exhibit a superconducting transition temperature in excess of 77K. R. B. ...

FOCUS - 48 OF 107 PATENTS

5,252,547

<=2> GET 1st DRAWING SHEET OF 1

Oct. 12, 1993

C 26

Method of forming an inorganic protective layer on an oxide superconducting film

INVENTOR: Itozaki, Hideo, Hyogo, Japan
Tanaka, Saburo, Hyogo, Japan
Fujita, Nobuhiko, Hyogo, Japan
Yazu, Shuji, Hyogo, Japan
Jodai, Tetsuji, Hyogo, Japan

SUM:

... term of quasi-perovskite type means a structure which can be considered to have such a crystal structure that is similar to Perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

The superconducting thin film may be also another type of superconductor consisting mainly of a compound oxide represented by the formula:

THETA 4(PHI 1 - q ,Ca q) m Cu ...
FOCUS - 49 OF 107 PATENTS

5,249,525

<=2> GET 1st DRAWING SHEET OF 11

Oct. 5, 1993

Spark-discharge lithography plates containing image-support pigments

INVENTOR: Lewis, Thomas E., E. Hampstead, New Hampshire
Nowak, Michael T., Gardner, Massachusetts

DETDESC:

... A perspective view of the first layer, labeled "Layer 0", appears in FIG. 6E. As shown in these figures, the spinel structure contains a number of octahedral sites for metal ions. Like perovskite structures spinels may also be defective, an example being gamma-Fe₂O₃. A spinel structure may also be intergrown with other structures.

In spinel compounds useful as image-support pigments, the ...
FOCUS - 50 OF 107 PATENTS

5,244,874

Sep. 14, 1993

Process for producing an elongated superconductor

INVENTOR: Yamamoto, Susumu, Hyogo, Japan
Kawabe, Nozomu, Hyogo, Japan
Awazu, Tomoyuki, Hyogo, Japan

DETDESC:

... term quasi-perovskite type means a structure which can be considered to have such a crystal structure that is similar to perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

Another superconducting compound oxide which can be prepared by the present invention is represented by the general formula:

(M, Sr)2CuO 4 - delta

in which M stands for Y or La and ...

FOCUS - 51 OF 107 PATENTS

5,241,191

<=2> GET 1st DRAWING SHEET OF 1

Aug. 31, 1993

Cubic perovskite crystal structure, a process of preparing the crystal structure, and articles constructed from the crystal structure

INVENTOR: Agostinelli, John A., Rochester, New York
Chen, Samuel, Penfield, New York

DETDESC:

... 1, PA-2, PA-3, PA-4 and PA-5, cited above and here incorporated by reference, can be employed. Highly compatible substrates are materials that themselves exhibit a perovskite or perovskite-like crystal structure. Strontium titanate is an example of a perovskite crystal structure which is specifically preferred for use as a substrate. Lanthanum aluminate (LaAlO₃), lanthanum gallium oxide (LaGaO₃) and potassium tantalate are ...

FOCUS - 52 OF 107 PATENTS

5,236,894

Aug. 17, 1993

Process for producing a superconducting thin film at relatively low temperature

INVENTOR: Tanaka, Saburo, Itami, Japan
Itozaki, Hideo, Itami, Japan
Higaki, Kenjiro, Itami, Japan
Yazu, Shuji, Itami, Japan
Jodai, Tetsuji, Itami, Japan

SUM:

... crystal structure. The term quasi-perovskite type means a structure which can be considered to be similar to perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

Still another example of the above-mentioned compound oxide is compound oxides represented by the general formula:

THETA 4(PHI 1 - q , Ca q) m Cu n O p + ...

FOCUS - 53 OF 107 PATENTS

5,221,660

<=2> GET 1st DRAWING SHEET OF 1

Jun. 22, 1993

Semiconductor substrate having a superconducting thin film

INVENTOR: Itozaki, Hideo, Hyogo, Japan
Harada, Keizo, Hyogo, Japan
Fujimori, Naoji, Hyogo, Japan
Yazu, Shuji, Hyogo, Japan
Jodai, Tetsuji, Hyogo, Japan

DETDESC:

... term quasi-perovskite type means a structure which can be considered to have such a crystal structure that is similar to perovskite-type oxides and includes an orthorhombically distorted perovskite or a distorted oxygen-deficient perovskite or the like.

An atomic ratio of the lanthanide element "Ln":Ba:Cu is preferably 1:2:3 as is defined by the formula but the atomic ratio is not restricted strictly to this ratio. In fact, the other compound oxides having ...

FOCUS - 54 OF 107 PATENTS

5,212,148

<=2> GET 1st DRAWING SHEET OF 1

May 18, 1993

Method for manufacturing oxide superconducting films by
laser evaporation

INVENTOR: Roas, Bernhard, Erlangen, Federal Republic of Germany
Endres, Gerhard, Forchheim, Federal Republic of Germany
Schultz, Ludwig, Bubenreuth, Federal Republic of Germany

SUM:

... yet exactly established. This initial product is then converted, by applying a heat and oxygen treatment, into the material with the desired superconducting phase.

The superconductive metal-oxide phases, to be obtained in this manner, can have perovskite-like crystal structures and, in the case of $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$, whereby $0 < x < 0.5$, have an orthorhombic structure (compare, for example, "Europhysics Letters", Vol. 3, No. 12, Jun. 15, 1987, pages ...

FOCUS - 55 OF 107 PATENTS

5,183,799

<=2> GET 1st DRAWING SHEET OF 16

Feb. 2, 1993

Superconducting materials including La-Sr-Nb-O , Y-Ba-Nb-O ,
 La-Sr-Nb-Cu-O , and Y-Ba-Nb-Cu-O

INVENTOR: Ogushi, Tetsuya, Kagoshima, Japan
Hakuraku, Yoshinori, Kagoshima, Japan
Ogata, Hisanao, Ibaraki, Japan

ABST:

... V, Nb, Ta, T, Zr or Hf; $0 < x < 1$; $0 < z < 1$; $i = 1, 3/2$ or 2 ; $0 < y <= 4$; G is F, Cl or N; delta is oxygen defect, and having a perovskite-like crystal structure, show superconductivity at a temperature higher than the liquid nitrogen temperature.

SUM:

BACKGROUND OF THE INVENTION

This invention relates to a superconducting material having a perovskite-like crystal structure and a superconducting part using the same, particularly to a superconducting material suitable for having a high superconducting transition temperature (T_c), and a process for producing the same.

Heretofore, ...

DETDESC:

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The superconducting materials of this invention have a perovskite-like crystal structure and represented by the formulae:

C 29

(L x A 1 - x) i MO y(1)

(L x A 1 - x) i M 1 - z Cu z ...

... by laminating this superconducting material with other films of electrical insulating material. It is preferable to laminate a plurality of film-like layers alternately, respectively. Further, it is preferable to use as an insulating material a perovskite-like ceramic of the same series.

Further, in the above-mentioned formulae (1) and (2), a total of valence number (p) of L, A and M, or L, A, M and Cu, and the valence number y of ...

... OMITTED p SYMBOL OMITTED = SYMBOL OMITTED y SYMBOL OMITTED +/- 0.5

Pat. No. 5183799, *

FOCUS

Further, it is preferable to include M of the valence of two.

More in detail, the material represented by the formula (1) has a perovskite-like crystal structure and has as the L element at least one element selected from the group consisting of scandium (Sc), yttrium (Y), and lanthanide elements of atomic numbers 57 to 71 (La to Lu) belonging to the group ...

... Ta) belonging to the group Vb of the periodic table and titanium (Ti), zirconium (Zr) and hafnium (Hf) belonging to the group IVb of the periodic table, these element being able to include Cu.

The oxide superconducting material having the perovskite-like crystal structure of this invention has as a fundamental constitution an octahedron having the M element which is an atom belonging to the group Vb or IVb as its center and 6 oxygen atoms. Since this material has defect of oxygen, that is, one or ...

... a mutual action of strong attraction necessary for forming a hole pair or electron pair showing a superconducting phenomenon at a temperature of 150K or higher.

The oxide superconducting material of this invention has the perovskite-like crystal structure as shown in FIGS. 1 and 2. These drawings show unit lattices of the materials represented by the formulae:

(L x A 1 - x) i MO y(1)

and (...

... formula (4) with at least one element selected from those of the group IVb and Vb, the total amount of the elements of the group IVb and Vb can exceed the amount of Cu.

It is also possible to produce an oxide superconducting powder having a perovskite-like crystal structure containing M element mainly by mixing a powder of oxide material represented by (L x A 1 - x) i CuO y , wherein x is 0 < x < 1; ...

... Cu:M = 1:1, carrying out substitution reaction between Cu and M element in vacuum, and finally pulverizing the final reaction product.

It is further possible to produce an oxide superconducting powder having a perovskite-like crystal structure and containing M element mainly by depositing in vacuum a film of pure metal of M element selected from the elements of groups IVb and Vb on outer surface of oxide ceramic ...

... 1, 3/2 or 2; y is 0 < y <= 4, containing the M element mainly (M being

Attachment D

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LEVEL 1 - 1 OF 2 PATENTS

5,134,042

<=2> GET 1st DRAWING SHEET OF 6

Jul. 28, 1992

Solid compositions for fuel cells, sensors and catalysts

INVENTOR: Madou, Marc J., Palo Alto, California
Otagawa, Takaaki, Fremont, California
Sher, Arden, Foster City, California

... [*12] selected from lanthanum, cerium, neodymium, praseodymium, or scandium, B is independently selected from strontium, calcium, barium or magnesium, Q is independently selected from nickel, cobalt, iron or manganese, and y is between about 0.0001 and 1, wherein the perovskite or perovskite-type structure has an average size and distribution of between about 50 and 200 Angstroms in diameter, and the composite layer of between about 25 and 1000 microns in thickness;

D1

said composite having multiple interfaces between:

...

PAGE

LEVEL 1 - 2 OF 2 PATENTS

4,948,680

<=2> GET 1st DRAWING SHEET OF 26

Aug. 14, 1990

Solid compositions for fuel cell electrolytes

INVENTOR: Madou, Marc J., Palo Alto, California
Otagawa, Takaaki, Fremont, California
Sher, Arden, Foster City, California

... [*25] 1.5 and d is between 0.001 and less than or equal to 3,
wherein either the first electrode material (C) or second electrode material
(A') comprises

A₁ - x B_x Q_{0.3}

having a perovskite or perovskite-type structure as an electrode catalyst in
combination with

A₁ - x B_x Z

as a polycrystalline solid electrolyte wherein

A is independently selected from lanthanum, cerium, neodymium, praseodymium
or scandium,

*** 2 PAGES 36 LINES JOB 53252 100G6J *
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D2

Attachment E

Perovskites and High T_c Superconductors

by

Francis S. Galasso

*United Technologies Research Laboratories
East Hartford, Connecticut
USA*

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E2

these compounds as
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Chapter II

Structure of Perovskite-type Compounds

Most of the compounds with the general formula ABO_3 have the perovskite structure. The atomic arrangement in this structure was first found for the mineral perovskite, CaTiO_3 . It was thought that the unit cell of CaTiO_3 could be represented by calcium ions at the corners of a cube with titanium ions at the body center and oxygen ions at the center of the faces (Fig. 2.1). This simple cubic structure has retained the name perovskite, even though CaTiO_3 was later determined to be orthorhombic by Megaw.⁽¹⁾ Through the years it has been found that very few perovskite-type oxides have the simple cubic structure at room temperature, but many assume this ideal structure at higher temperatures.

In the perovskite structure, the A cation is coordinated with twelve oxygen ions and the B cation with six. Thus, the A cation is normally found to be somewhat larger than the B cation. In order to have contact between the A, B, and O ions, $R_A + R_O$ should equal $\sqrt{2}(R_B + R_O)$, where R_A , R_B and R_O are the ionic radii. Goldschmidt⁽²⁾ has shown that the cubic perovskite structure is stable only if a tolerance factor, t defined by $R_A + R_O = t\sqrt{2}(R_B + R_O)$, has an approximate range of $0.8 < t < 0.9$, and a somewhat larger range for distorted perovskite structures. It should be noted that conflicting reports in the literature make it difficult to assign the correct unit cell dimensions for these distorted perovskite structures.

The ternary perovskite-type oxides described in this chapter will be divided into $\text{A}^{1+}\text{B}^{5+}\text{O}_3$, $\text{A}^{2+}\text{B}^{4+}\text{O}_3$, $\text{A}^{3+}\text{B}^{3+}\text{O}_3$ types and oxygen- and cation-deficient phases. The oxygen- and cation-deficient phases will be regarded as those which contain considerable vacancies and not those phases which are only slightly non-stoichiometric. Many of these contain B ions of one element in two valence states and should

Attachment F

COPPER OXIDE SUPERCONDUCTORS

Charles P. Poole, Jr.

Timir Datta

Horacio A. Farach

with help from

M. M. Rigney

C. R. Sanders

*Department of Physics and Astronomy
University of South Carolina
Columbia, South Carolina*



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F1

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F2

tetragonal phase, and the metal-to-insulator transition occurs at the tetragonal-to-orthorhombic phase boundary $x \approx 0.35$ (Matt7, Slei1).

D. PEROVSKITE-TYPE SUPERCONDUCTING STRUCTURES

In their first report on high-temperature superconductors Bednorz and Müller referred to their samples as "metallic, oxygen deficient . . . perovskite like mixed valent copper compounds." Subsequent work has confirmed that the new superconductors do indeed have these characteristics. In this section we will comment on their perovskite-like aspects.

1. Atom Sizes

In the oxide superconductors Cu replaces the Ti^{4+} ions (0.68 \AA) of perovskite, and in most cases retains the CuO_2 layering with two oxygens per copper in the layer. Other cationic replacements tend to be Bi, Ca, La, Sr, Tl, and Y for the larger Ba, forming "layers" containing only one oxygen or none per cation. We see from the following list of ionic radii

Cu^{2+}	0.72 \AA	
Bi^{5+}	0.74 \AA	
Y^{3+}	0.94 \AA	
Tl^{3+}	0.95 \AA	
Bi^{3+}	0.96 \AA	
Ca^{2+}	0.99 \AA	(VI-4)
Sr^{2+}	1.12 \AA	
La^{3+}	1.14 \AA	
Ba^{2+}	1.34 \AA	
O^{2-}	1.32 \AA	

that there are four size groups, with all other cations significantly smaller than the Ba of perovskite. The common feature of CuO_2 layers that are planar or close to planar establishes a fairly uniform lattice size in the a,b plane. The parameters of the compounds $LaSrCuO$ ($a = b = 3.77 \text{ \AA}$), $YBaCuO$ ($a = 3.83 \text{ \AA}$, $b = 3.89 \text{ \AA}$), $BiSrCaCuO$ ($a = b = 3.82 \text{ \AA}$), and $TlBaCaCuO$ ($a = b = 3.86 \text{ \AA}$) are all between the ideal fcc oxygen lattice value of 3.73 \AA and the perovskite one of 4.01 \AA .

Table VI-2 gives the ionic radii of the positively charged ions of various elements of the periodic table. These radii are useful for estimating changes in lattice constant when ionic substitutions are made in existing structures. They also provide some insight into which types of substitutions will be most favorable.

TABLE VI-2. Ionic Radii in Angstroms of Selected Elements for Various Positive Charge States^a

Z	Element	+1	+2	+3	+4	+5	+6
<i>Alkali</i>							
3	Li	0.68					
11	Na	0.97					
19	K	1.33					
37	Rb	1.47					
55	Cs	1.67					
<i>Alkaline earths</i>							
4	Be	0.44	0.35				
12	Mg	0.82	0.66				
20	Ca	1.18	0.99				
38	Sr		1.12				
56	Ba	1.53	1.34				
<i>Group III</i>							
5	B	0.35		0.23			
13	Al			0.51			
31	Ga	0.81		0.62			
49	In			0.81			
81	Tl	1.47		0.95			
<i>Group IV</i>							
(VI-4)	6	C			0.16		
	14	Si	0.65		0.42		
	32	Ge		0.73	0.53		
	50	Sn		0.93	0.71		
	82	Pb		1.20	0.84		
<i>Group V</i>							
	15	P			0.44	0.35	
	33	As			0.58	0.46	
	51	Sb	0.89		0.76	0.62	
	83	Bi	0.98		0.96	0.74	
<i>Chalcogenides</i>							
	16	S			0.37	0.30	
	34	Se	0.66		0.50	0.42	
	52	Te	0.82		0.70	0.56	
<i>First transition series (3dⁿ)</i>							
	21	Sc			0.81		
	22	Ti	0.96	0.94	0.76	0.68	
	23	V		0.88	0.74	0.63	0.59
	24	Cr	0.81	0.89	0.63		
	25	Mn		0.80	0.66	0.60	0.52

TABLE VI-2. (continued)

Z	Element	+1	+2	+3	+4	+5	+6
26	Fe		0.74	0.64			
27	Co		0.72	0.63			
28	Ni		0.69				
29	Cu	0.96	0.72				
30	Zn	0.88	0.74				
<i>Second transition series (4dⁿ)</i>							
39	Y			0.94			
40	Zr	1.09			0.79		
41	Nb	1.00			0.74	0.69	
42	Mo	0.93			0.70		0.62
43	Tc						
44	Ru				0.67		
45	Rh			0.68			
46	Pd		0.80		0.65		
47	Ag	1.26	0.89				
48	Cd	1.14	0.97				
<i>Third transition series (5dⁿ)</i>							
72	Hf				0.78		
73	Ta					0.68	
74	W				0.70		0.62
75	Re				0.72		
76	Os				0.88		0.69
77	Ir				0.68		
78	Pt		0.80		0.65		
79	Au	1.37		0.85			
80	Hg	1.27	1.10				
<i>Rare earths (4fⁿ)</i>							
57	La	1.39		1.14			
58	Ce	1.27		1.07	0.94		
59	Pr			1.06	0.92		
60	Nd			1.04			
61	Pm			1.06			
62	Sm			1.00			
63	Eu			0.98			
64	Gd			0.62			
65	Tb			0.93	0.81		
66	Dy			0.92			
67	Ho			0.91			
68	Er			0.89			
69	Tm			0.87			
70	Yb			0.86			
71	Lu			0.85			

*Three anion radii are 1.32 for O²⁻, 1.33 for F⁻, and 1.84 for S²⁻ (*Handbook of Chemistry and Physics*).

Attachment G

COPPER OXIDE SUPERCONDUCTORS

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with help from

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VI

CRYSTALLOGRAPHIC STRUCTURES

A. INTRODUCTION

To properly understand the mechanisms that bring about the superconducting state in particular materials it is necessary to know the structures of the compounds that exhibit this phenomenon. Single-crystal structure studies have been carried out to determine the dimensions of the unit cell, the locations of the atoms in this cell, electronic charge distributions, and the possible presence of atomic irregularities. Neutron powder diffraction has also provided much of the detailed structure information found in this chapter (e.g., Antso, Beech, Cappo, Coxzz, Davil, Dayzz, Greed, John4, Jorge, Jorg1, Paulz, Torar, Vakni, Yamag, Yanz2). More routine X-ray powder pattern measurements which can identify a known structure and provide the unit cell dimensions are useful for checking the quality of samples, as was explained in Section V-I.

The numerical values of quantities such as lattice parameters and bond lengths show some variation in the literature, and many of our quoted values will be typical ones. Much of the quantitative structural information is organized in the tables.

In the beginning of this chapter we will introduce the perovskite structure and indicate how it is related to the oxide superconductors. Then we will describe the 21 structure of LaSrCuO and the 123 structure of YBaCuO, we will show how each is generated from a perovskite prototype, and we will clarify its layering scheme. The chapter will end with descriptions of the structures of the newer high-transition-temperature bismuth and thallium compounds.

B. PEROVSKITES

Much has been written about the oxide superconductor compounds being perovskite types, so we will begin with a description of the perovskite structure. This will permit us to develop some of the notation to be used in describing the structures of the superconductors themselves.

1. Cubic Form

Above 200°C barium titanate crystallizes in the perovskite structure, which is cubic, so the three lattice parameters are all equal (i.e., $a = b = c$). The unit cell contains one formula unit BaTiO_3 and the atoms are located in the following special positions (Wyckoff, p. 390):

$$\begin{array}{lll} \text{Ba} & (1a) & \frac{1}{2}, \frac{1}{2}, \frac{1}{2} \\ \text{Ti} & (1b) & 0, 0, 0 \\ \text{O} & (3c) & 0, 0, \frac{1}{2}; 0, \frac{1}{2}, 0; \frac{1}{2}, 0, 0 \end{array} \quad (\text{VI-1})$$

where we have employed the crystallographic notation (1a) for an a-type lattice site which contains one atom, (3c) for a c-type lattice site which contains three atoms, and so on. Each atomic position is given by three coordinates, such as $0, 0, \frac{1}{2}$ for the oxygen located at $x = 0, y = 0, z = 0.5a$. This arrangement corresponds to placing a titanium atom on each apex, a barium atom in the body center, and an oxygen atom on the center of each edge of the cube, as illustrated on Fig. VI-1. We see from the figure that the barium atoms are 12-fold coordinated and the titaniums have sixfold (octahedral) coordination. The lattice constant or length of the unit cell is $a = 4.0118 \text{ \AA}$ at 201°C . The crystallographic space group is $Pm3m, O_h^1$.

An alternate way to represent this structure, which is commonly used in solid-state texts and in crystallography monographs (e.g., Wyck2), is to locate the

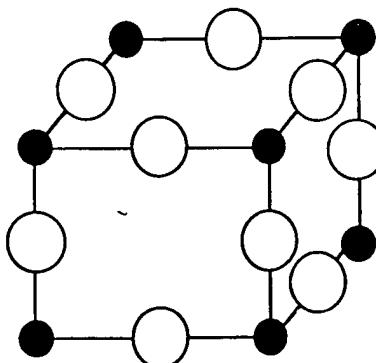


Fig. VI-1. Perovskite cubic unit cell showing titanium on the apices and oxygen in the edge-centered positions. Barium, which is in the body center, is not shown.

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vskite structure and we will describe the β , we will show how clarify its layering structures of the newer kinds.

origin at the barium site; this places titanium in the center and the oxygens on the centers of the cube faces. The representation (Eq. VI-1) given above is more convenient for comparison with the structures of the oxide superconductors.

The compound $\text{LaBaCu}_2\text{O}_5$ was found to have a cubic perovskite subcell with the lattice parameter $a = 3.917 \text{ \AA}$ (Sishe).

2. Tetragonal Form

At room temperature barium titanate is tetragonal with the unit cell dimensions $a = 3.9947 \text{ \AA}$ and $c = 4.0336 \text{ \AA}$, which is close to cubic. For this lower symmetry the oxygens are assigned to two different sites, a single site along the side edges and a twofold one at the top and bottom. The atomic positions (Wyck2, p. 401)

Ba	$\frac{1}{2}, \frac{1}{2}, 0.488$			
Ti	0, 0, 0			
O(1)	0, 0, 0.511			
O(2)	$0, \frac{1}{2}, -0.026; \frac{1}{2}, 0, -0.026$			

(VI-2)

are shown in Fig. VI-2. The distortions from the ideal structure of Fig. VI-1 are exaggerated on this sketch. We will see later that a similar distortion occurs in the YBaCuO structure. The cubic and tetragonal atom arrangements (VI-1) and (VI-2) are compared in Table VI-1, and we see from this table that the deviation from cubic symmetry is actually quite small.

3. Orthorhombic Form

When barium titanate is cooled below 5°C it undergoes a transition with a further lowering of the symmetry to the orthorhombic space group $\text{Amm}2$, C_{2v} , and

TABLE VI-1. Comparison of Atom Positions of BaTiO_3 in Its Cubic, Tetragonal and Orthorhombic Forms*

Group	Atom	Cubic and Tetragonal		Cubic x	Tetragonal y	Orthorhombic z
		x	y			
TiO_2	Ti	0	0	1	1	1
	O	0	$\frac{1}{2}$	1	0.974	1
	O	$\frac{1}{2}$	0	1	0.974	1
BaO	O	0	0	$\frac{1}{2}$	0.511	$\frac{1}{2}$
	Ba	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	0.488	$\frac{1}{2}$
	Ti	0	0	0	0	0
TiO_2	O	0	$\frac{1}{2}$	0	-0.026	0
	O	$\frac{1}{2}$	0	0	-0.026	0

*The x and y coordinates are the same for both positions. The orthorhombic form z coordinates are also given (Wyck2, pp. 390, 401, 405).

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Cubic, Tetragonal and

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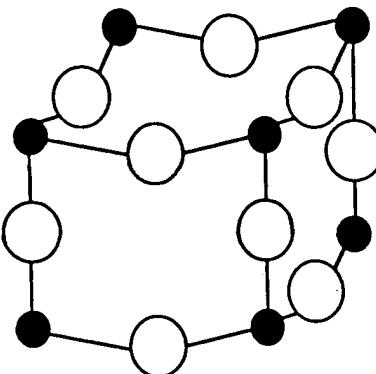


Fig. VI-2. Perovskite tetragonal unit cell showing the puckering of the Ti-O layers.

an enlargement of the unit cell to accommodate two formula units ($BaTiO_3$)₂. The enlarged cell is rotated by 45° relative to the higher-temperature ones, as shown on Fig. VI-3, and therefore its a and b lattice parameters are larger by the factor $\sqrt{2}$. The three lattice constants are $a = 5.669 = 4.009\sqrt{2}$ Å, $b = 5.682 = 4.018\sqrt{2}$ Å, and $c = 3.990$ Å. There are no longer any special sites, and the atomic positions are (Wyck2, p. 405):

$$\begin{array}{ll} Ba & (2a) \quad 0, \frac{1}{2}, \frac{1}{2}; \frac{1}{2}, 0, \frac{1}{2} \\ Ti & (2b) \quad 0, u + \frac{1}{2}, 0; \frac{1}{2}, u, 0 \quad \text{with } u = 0.510 \\ O(1) & (2a) \quad 0, u + \frac{1}{2}, \frac{1}{2}; \frac{1}{2}, u, \frac{1}{2} \quad \text{with } u = 0.490 \\ O(2) & (4e) \quad u, v + \frac{1}{2}, 0; -u, v + \frac{1}{2}, 0; u + \frac{1}{2}, v, 0; -u + \frac{1}{2}, v, 0 \\ & \quad \text{with } u = 0.253, v = 0.237 \end{array} \quad (VI-3)$$

where $u = 0$ for Ba.

One should note that in Eq. (VI-3) Ba and O(1) are in the same (2a) type of site with different values of the parameter u . Figure VI-3 shows the coordinates of the atoms in the orthorhombic cell drawn using the approximation $\approx \frac{1}{2}$ for 0.490 and 0.510 and $\approx \frac{1}{4}$ for 0.253 and 0.237.

A comparison of Eqs. VI-1 to VI-3 indicates that the transformation from cubic to tetragonal involves only shifts in the z coordinates of atoms, while the orthorhombic phase differs from the cubic one only through shifts in atom positions within x, y planes (see Table VI-1).

4. Atom Arrangements

The ionic radii of Ba^{2+} (1.34 Å) and O^{2-} (1.32 Å) are almost the same, and together they form a face-centered cubic (fcc) close-packed lattice with the smaller Ti^{4+} ions (0.68 Å) located in octahedral holes. The octahedral holes of a close-packed oxygen lattice have a radius of 0.545 Å, and if these holes were empty the lattice parameter would be $a = 3.73$, as shown on Fig. VI-4a. If each

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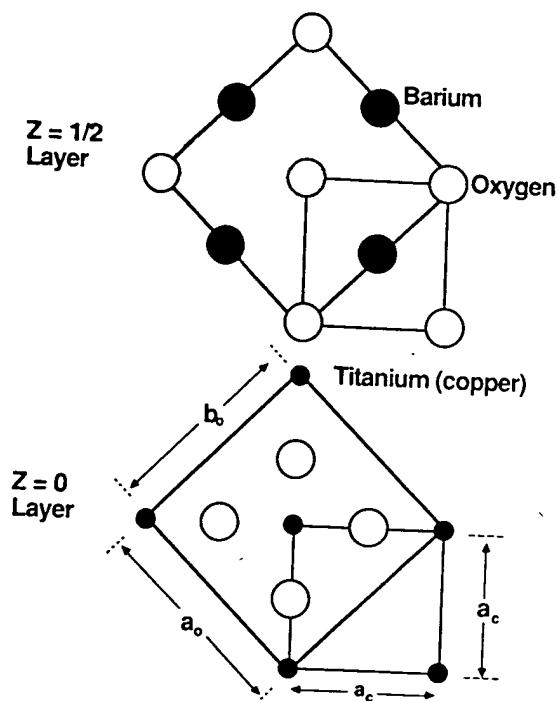


Fig. VI-3. Atom positions of perovskite when the monomolecular tetragonal unit cell is expanded to the bimolecular orthorhombic cell with new axes at 45° with respect to the old ones.

titanium were to move the surrounding oxygens apart to its ionic radius when occupying the hole, as shown on Fig. VI-4b, the lattice parameter a would be 4.00 \AA . The observed cubic ($a = 4.012 \text{ \AA}$) and tetragonal ($a = 3.995 \text{ \AA}, c = 4.034 \text{ \AA}$) lattice parameters are close to these values, indicating a pushing apart of the oxygens. The tetragonal distortion illustrated on Fig. VI-2 and the orthorhombic distortion of Eq. (VI-3) constitute attempts to achieve this through an enlarged but distorted octahedral site. This same mechanism is operative in the oxide superconductors.

C. BARIUM-LEAD-BISMUTH OXIDE

In 1983 Mattheiss and Hamann referred to the 1975 "discovery by Sleight et al. of high temperature superconductivity" of the compound $\text{BaPb}_{1-x}\text{Bi}_x\text{O}_3$ in the composition range $0.05 \leq x \leq 0.3$ with T_c up to 13 K (Matt7, Sleig). Many consider this system, which disproportionates $2 \text{ Bi}^{4+} \rightarrow \text{Bi}^{3+} + \text{Bi}^{5+}$ in going from the metallic to the semiconducting state, as a predecessor to the LaSrCuO system.

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TABLE VI-3. Atom Positions of Regular and Alternate La_2CuO_4 Structure, Both of Which Correspond to Space Group $I4/mmm$, D_{4h}^{17a}

Complex	Ideal z	Atom	Regular Structure			Alternate Structure		
			Site	x	y	Site	x	y
CuO_2	1	O(1)	4c	$\frac{1}{2}$	0	1	0.5	0
		O(1)	4c	0	$\frac{1}{2}$	1	0	$\frac{1}{2}$
	$\frac{5}{6} = 0.833$	Cu	2a	0	0	1	0	0
		La	4e	$\frac{1}{2}$	$\frac{1}{2}$	0.862	0.5	$\frac{1}{2}$
OLa	$\frac{2}{3} = 0.667$	O(2)	4e	0	0	0.818	0	$\frac{3}{4}$
		La	4e	0	0	0.682	0	$\frac{1}{4}$
	$\frac{1}{2}$	O(1)	4c	0	$\frac{1}{2}$	$\frac{1}{2}$	0	$\frac{1}{2}$
		O(1)	4c	$\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
LaO	$\frac{1}{3} = 0.333$	Cu	2a	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
		La	4e	0	0	0.362	0	$\frac{1}{2}$
	$\frac{1}{6} = 0.167$	O(2)	4e	$\frac{1}{2}$	$\frac{1}{2}$	0.318	0	$\frac{1}{4}$
		La	4e	0	0	0.182	0	$\frac{1}{2}$
$\text{O}_{2\text{Cu}}$	$\frac{1}{2}$	O(2)	4e	$\frac{1}{2}$	$\frac{1}{2}$	0.138	0	$\frac{1}{4}$
		La	4e	$\frac{1}{2}$	$\frac{1}{2}$	0	0	0.138
	$\frac{1}{2}$	O(1)	4c	$\frac{1}{2}$	0	0	$\frac{1}{2}$	0
		O(1)	4c	0	$\frac{1}{2}$	0	$\frac{1}{2}$	0
CuO_2	0	Cu	2a	0	0	0	0	0
		La	4e	0	0	0	0	0
	$\frac{1}{2}$	O(1)	4c	$\frac{1}{2}$	$\frac{1}{2}$	0	$\frac{1}{2}$	0
		O(1)	4c	0	$\frac{1}{2}$	0	$\frac{1}{2}$	0

*Superconducting compounds crystallize in the regular structure (Oguchi; see also Onoda). The ideal z values in column 2 are for the prototype perovskite.

constants for tetragonal LaSrCuO superconductors with various values of x , y , and δ in the formula $(\text{La}_{1-x}\text{Sr}_x)_{2-y}\text{CuO}_{4-\delta}$.

2. Alternate Tetragonal Form

In the previous section we discussed the tetragonal structure which is adopted by LaSrCuO superconductors. It has a variant (Hutir, Oguchi) called the Nd_2CuO_4 structure in which the oxygens O(2) are in special sites (4d) instead of the general (4e) sites in the same space group, corresponding to

$$\text{O}(2) \quad (4d) \quad 0, \frac{1}{2}, \frac{1}{4}; \frac{1}{2}, 0, \frac{1}{4}; \frac{1}{2}, 0, \frac{3}{4}; 0, \frac{1}{2}, \frac{3}{4} \quad (\text{VI-7})$$

The remaining atoms are in the positions given by Eq. (VI-6) and listed in Table VI-3, and the unit cell is sketched on the right-hand side of Fig. VI-5. This structure tends to be unstable relative to its K_2NiF_4 counterpart, and is not known to superconduct.

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tetragonal phase, and the metal-to-insulator transition occurs at the tetragonal-to-orthorhombic phase boundary $x \approx 0.35$ (Matt7, Slei1).

D. PEROVSKITE-TYPE SUPERCONDUCTING STRUCTURES

In their first report on high-temperature superconductors Bednorz and Müller referred to their samples as "metallic, oxygen deficient . . . perovskite like mixed valent copper compounds." Subsequent work has confirmed that the new superconductors do indeed have these characteristics. In this section we will comment on their perovskite-like aspects.

1. Atom Sizes

In the oxide superconductors Cu replaces the Ti^{4+} ions (0.68 \AA) of perovskite, and in most cases retains the CuO_2 layering with two oxygens per copper in the layer. Other cationic replacements tend to be Bi, Ca, La, Sr, Tl, and Y for the larger Ba, forming "layers" containing only one oxygen or none per cation. We see from the following list of ionic radii

Cu^{2+}	0.72 \AA	
Bi^{5+}	0.74 \AA	
Y^{3+}	0.94 \AA	
Tl^{3+}	0.95 \AA	
Bi^{3+}	0.96 \AA	
Ca^{2+}	0.99 \AA	(VI-4)
Sr^{2+}	1.12 \AA	
La^{3+}	1.14 \AA	
Ba^{2+}	1.34 \AA	
O^{2-}	1.32 \AA	

that there are four size groups, with all other cations significantly smaller than the Ba of perovskite. The common feature of CuO_2 layers that are planar or close to planar establishes a fairly uniform lattice size in the a, b plane. The parameters of the compounds $LaSrCuO$ ($a = b = 3.77 \text{ \AA}$), $YBaCuO$ ($a = 3.83 \text{ \AA}, b = 3.89 \text{ \AA}$), $BiSrCaCuO$ ($a = b = 3.82 \text{ \AA}$), and $TlBaCaCuO$ ($a = b = 3.86 \text{ \AA}$) are all between the ideal fcc oxygen lattice value of 3.73 \AA and the perovskite one of 4.01 \AA .

Table VI-2 gives the ionic radii of the positively charged ions of various elements of the periodic table. These radii are useful for estimating changes in lattice constant when ionic substitutions are made in existing structures. They also provide some insight into which types of substitutions will be most favorable.

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TABLE VI-2. Ionic Radii in Angstroms of Selected Elements for Various Positive Charge States^a

Z	Element	+1	+2	+3	+4	+5	+6
<i>Alkali</i>							
3	Li	0.68					
11	Na	0.97					
19	K	1.33					
37	Rb	1.47					
55	Cs	1.67					
<i>Alkaline earths</i>							
4	Be	0.44	0.35				
12	Mg	0.82	0.66				
20	Ca	1.18	0.99				
38	Sr		1.12				
56	Ba	1.53	1.34				
<i>Group III</i>							
5	B	0.35		0.23			
13	Al			0.51			
31	Ga	0.81		0.62			
49	In			0.81			
81	Tl	1.47		0.95			
<i>Group IV</i>							
6	C				0.16		
14	Si	0.65			0.42		
32	Ge		0.73		0.53		
50	Sn		0.93		0.71		
82	Pb		1.20		0.84		
<i>Group V</i>							
15	P			0.44		0.35	
33	As			0.58		0.46	
51	Sb	0.89		0.76		0.62	
83	Bi	0.98		0.96		0.74	
<i>Chalcogenides</i>							
16	S				0.37		0.30
34	Se	0.66			0.50		0.42
52	Te	0.82			0.70		0.56
<i>First transition series ($3d^n$)</i>							
21	Sc			0.81			
22	Ti	0.96	0.94	0.76	0.68		
23	V		0.88	0.74	0.63	0.59	
24	Cr	0.81	0.89	0.63			0.52
25	Mn		0.80	0.66	0.60		

6 10

TABLE VI-2. (continued)

Z	Element	+1	+2	+3	+4	+5	+6
26	Fe		0.74	0.64			
27	Co		0.72	0.63			
28	Ni		0.69				
29	Cu	0.96	0.72				
30	Zn	0.88	0.74				
<i>Second transition series ($4d^n$)</i>							
39	Y			0.94			
40	Zr	1.09			0.79		
41	Nb	1.00			0.74	0.69	
42	Mo	0.93			0.70		0.62
43	Tc						
44	Ru				0.67		
45	Rh			0.68			
46	Pd		0.80		0.65		
47	Ag	1.26	0.89				
48	Cd	1.14	0.97				
<i>Third transition series ($5d^n$)</i>							
72	Hf			0.78			
73	Ta					0.68	
74	W				0.70		0.62
75	Re				0.72		
76	Os				0.88		0.69
77	Ir				0.68		
78	Pt		0.80		0.65		
79	Au	1.37		0.85			
80	Hg	1.27	1.10				
<i>Rare earths ($4f^n$)</i>							
57	La	1.39		1.14			
58	Ce	1.27		1.07	0.94		
59	Pr			1.06	0.92		
60	Nd			1.04			
61	Pm			1.06			
62	Sm			1.00			
63	Eu			0.98			
64	Gd			0.62			
65	Tb			0.93	0.81		
66	Dy			0.92			
67	Ho			0.91			
68	Er			0.89			
69	Tm			0.87			
70	Yb			0.86			
71	Lu			0.85			

*Three anion radii are 1.32 for O^{2-} , 1.33 for F^- , and 1.84 for S^{2-} (*Handbook of Chemistry and Physics*).

+5 +6

2. Unit Cell Stacking

Three and four fundamental fcc unit cells stack vertically to form the superconducting unit cells of YBaCuO and LaSrCuO , respectively, with some oxygens removed in the process. This causes the vertical height or c parameter of the unit cell to be less than that expected for the stacking of perovskite cells:

$$\begin{aligned} \text{YBaCuO: } c &\approx 11.7 \text{ \AA}, 3c_{\text{fcc}} = 11.19 \text{ \AA}, 3c_{\text{per}} = 12.03 \text{ \AA} \\ \text{LaSrCuO: } c &\approx 13.18 \text{ \AA}, 4c_{\text{fcc}} = 14.92 \text{ \AA}, 4c_{\text{per}} = 16.04 \text{ \AA} \end{aligned} \quad (\text{VI-5})$$

Similar stackings occur in the BiSrCaCuO and TlBaCaCuO compounds.

0.69 0.62

E. LANTHANUM-COPPER OXIDE

The structure of LaSrCuO , $(\text{La}_{1-x}\text{M}_x)_2\text{CuO}_{4-\delta}$, called the 21 structure, where M is usually Sr or Ba, is tetragonal in some cases and orthorhombic in others. We will describe the tetragonal case first and then the orthorhombic distortion of it. The structures will be described in terms of the prototype compound La_2CuO_4 corresponding to $x = \delta = 0$ in the above expression, keeping in mind that in the superconducting compounds themselves some of the La atoms are replaced by a divalent cation such as Sr or Ba. Since lanthanum has a charge of +3 and oxygen is -2, it follows that all of the copper is divalent (+2) when $x = 0$, and some becomes trivalent for $x > 0$.

The compound La_2CuO_4 itself is considered to be nonsuperconducting, but some investigators claim that it or portions of it do exhibit superconductivity, perhaps of a filamentary type (Beill, Coop1, Dvora, Gran1, Pick1, Shahe, Skelt, Skell1, Skel2).

0.68 0.62 0.69

1. Tetragonal Form

The tetragonal LaSrCuO superconductors crystallize in what is called the K_2NiF_4 structure with space group $I4/mmm$, D_{4h}^{17} and two formula units per unit cell (e.g., Burns, Coll1, Hirot, Mossz, Onoda; Wyck3, p. 68). The copper atoms and one of the oxygen types O(1) are in special positions and the remaining atoms are all in general positions, with a single undetermined parameter associated with the z coordinate. The positions are

$$\begin{array}{ll} \text{La} & (4e) \quad 0,0,u; 0,0,-u; \frac{1}{2},\frac{1}{2},u+\frac{1}{2}; \frac{1}{2},\frac{1}{2},-u+\frac{1}{2} \\ \text{Cu} & (2a) \quad 0,0,0; \frac{1}{2},\frac{1}{2},\frac{1}{2} \\ \text{O}(1) & (4c) \quad 0,\frac{1}{2},0; \frac{1}{2},0,0; \frac{1}{2},0,\frac{1}{2}; 0,\frac{1}{2},\frac{1}{2} \\ \text{O}(2) & (4e) \quad 0,0,v; 0,0,-v; \frac{1}{2},\frac{1}{2},v+\frac{1}{2}; \frac{1}{2},\frac{1}{2},-v+\frac{1}{2} \end{array} \quad (\text{VI-6})$$

with $u = 0.362$ and $v = 0.182$. Typical lattice dimensions are $a = b = 3.77 \text{ \AA}$, $c = 13.18 \text{ \AA}$. Table VI-3 gives more details on the atom positions and Fig. VI-5a provides a sketch of this 21 structure. Table VI-4 lists the measured lattice

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TABLE VI-3. Atom Positions of Regular and Alternate La_2CuO_4 Structure, Both of Which Correspond to Space Group $I4/mmm$, D_{4h}^{17a}

Complex	Ideal z	Regular Structure						Alternate Structure					
		Atom	Site	x	y	z	Atom	Site	x	y	z		
CuO_2	1	O(1)	4c	$\frac{1}{2}$	0	1	O(1)	4c	$\frac{1}{2}$	0	1		
		O(1)	4c	0	$\frac{1}{2}$	1	O(1)	4c	0	$\frac{1}{2}$	1		
OLa	$\frac{5}{6} = 0.833$	Cu	2a	0	0	1	Cu	2a	0	0	1		
		La	4e	$\frac{1}{2}$	$\frac{1}{2}$	0.862	La	4e	$\frac{1}{2}$	$\frac{1}{2}$	0.862		
LaO	$\frac{2}{3} = 0.667$	O(2)	4e	0	0	0.818	O(2)	4d	0	$\frac{1}{2}$	$\frac{3}{4}$		
		La	4e	0	0	0.638	La	4d	$\frac{1}{2}$	0	$\frac{3}{4}$		
O_2Cu	$\frac{1}{2}$	O(1)	4c	0	$\frac{1}{2}$	$\frac{1}{2}$	O(1)	4c	0	$\frac{1}{2}$	$\frac{1}{2}$		
		O(1)	4c	$\frac{1}{2}$	0	$\frac{1}{2}$	O(1)	4c	$\frac{1}{2}$	0	$\frac{1}{2}$		
LaO	$\frac{1}{3} = 0.333$	Cu	2a	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	Cu	2a	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$		
		La	4e	0	0	0.362	La	4e	0	0	0.362		
OLa	$\frac{1}{6} = 0.167$	O(2)	4e	$\frac{1}{2}$	$\frac{1}{2}$	0.318	O(2)	4d	$\frac{1}{2}$	0	$\frac{1}{4}$		
		La	4e	$\frac{1}{2}$	$\frac{1}{2}$	0.138	La	4d	0	$\frac{1}{2}$	$\frac{1}{4}$		
CuO_2	0	O(1)	4c	$\frac{1}{2}$	0	0	O(1)	4c	$\frac{1}{2}$	0	0		
		O(1)	4c	0	$\frac{1}{2}$	0	O(1)	4c	0	$\frac{1}{2}$	0		
		Cu	2a	0	0	0	Cu	2a	0	0	0		

*Superconducting compounds crystallize in the regular structure (Oguchi; see also Onoda). The ideal z values in column 2 are for the prototype perovskite.

constants for tetragonal LaSrCuO superconductors with various values of x , y , and δ in the formula $(\text{La}_{1-x}\text{Sr}_x)_{2-y}\text{CuO}_{4-\delta}$.

2. Alternate Tetragonal Form

In the previous section we discussed the tetragonal structure which is adopted by LaSrCuO superconductors. It has a variant (Hutir, Oguchi) called the Nd_2CuO_4 structure in which the oxygens O(2) are in special sites (4d) instead of the general (4e) sites in the same space group, corresponding to

$$\text{O}(2) \quad (4d) \quad 0, \frac{1}{2}, \frac{1}{4}; \frac{1}{2}, 0, \frac{1}{4}; \frac{1}{2}, 0, \frac{3}{4}; 0, \frac{1}{2}, \frac{3}{4} \quad (\text{VI-7})$$

The remaining atoms are in the positions given by Eq. (VI-6) and listed in Table VI-3, and the unit cell is sketched on the right-hand side of Fig. VI-5. This structure tends to be unstable relative to its K_2NiF_4 counterpart, and is not known to superconduct.

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ture, Both of

Lanthanum Copper Oxide Tetragonal Unit Cell			
	x	y	z
c	$\frac{1}{2}$	0	1
c	0	$\frac{1}{2}$	1
a	0	0	1
e	$\frac{1}{2}$	$\frac{1}{2}$	0.862
d	0	$\frac{1}{2}$	$\frac{3}{4}$
d	$\frac{1}{2}$	0	$\frac{3}{4}$
e	0	0	0.638
c	0	$\frac{1}{2}$	$\frac{1}{2}$
c	$\frac{1}{2}$	0	$\frac{1}{2}$
a	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
e	0	0	0.362
d	$\frac{1}{2}$	0	$\frac{1}{4}$
d	0	$\frac{1}{2}$	$\frac{1}{4}$
e	$\frac{1}{2}$	$\frac{1}{2}$	0.138
c	$\frac{1}{2}$	0	0
c	0	$\frac{1}{2}$	0
a	0	0	0

(also Onoda). The ideal

ious values of x , y ,

which is adopted by
called the Nd_2CuO_4
stead of the general

$$(VI-7)$$

and listed in Table
g. VI-5. This struc-
ind is not known to

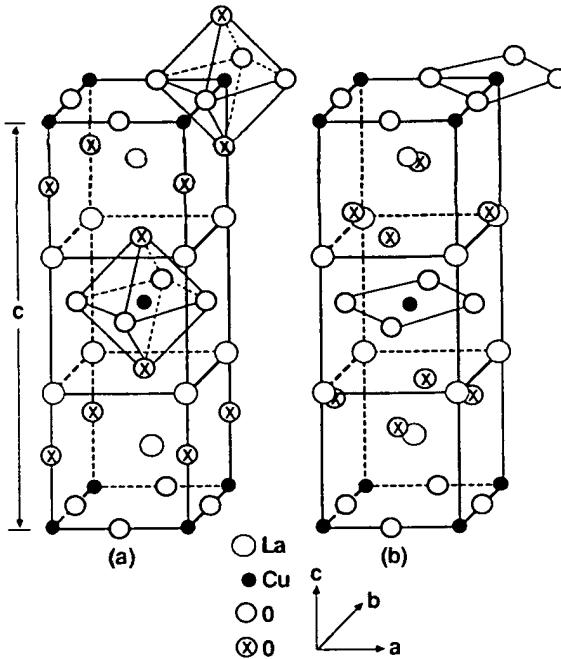


Fig. VI-5. Lanthanum copper oxide tetragonal unit cell. The regular cell (a) associated with the superconducting compounds is shown on the left and the alternative one (b) is on the right (Oguchi; see also Ohba1). The oxygens denoted by \otimes have different positions in the two cells.

3. Orthorhombic Form

The 21 orthorhombic LaSrCuO structure (Longo) is related to its tetragonal analogue given by Eq. (VI-6) in the same way that the orthorhombic perovskite structure (VI-3) is related to its tetragonal (VI-2) and cubic (VI-1) forms. This means that the orthorhombic basis directions are at 45° relative to the tetragonal ones, and the number of formula units in the cell is doubled. The situation is similar to that described by Fig. VI-3, with $a = 5.363 \text{ \AA} = 3.792\sqrt{2} \text{ \AA}$, $b = 5.409 \text{ \AA} = 3.825\sqrt{2} \text{ \AA}$, $c = 13.17 \text{ \AA}$. Writing the a and b lattice parameters times $\sqrt{2}$ compensates for the new choice of axes and shows that the orthorhombic values are close to the tetragonal $a = 3.81 \text{ \AA}$ given earlier. There is also very little change in c . Table VI-5 lists the measured lattice constants for several orthorhombic compounds. The anisotropy factors ANIS

$$\text{ANIS} = \frac{100 |b - a|}{0.5 (b + a)} \quad (\text{VI-8})$$

listed in column 6 give the percentage deviation from tetragonality.

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TABLE VI-4. Selected Lattice Parameters for $(R_{1-x}M_x)_2CuO_{4-\delta}$ Type Superconductors with Tetragonal Structure^a

R-M	x	Lattice Parameters ^b		Ref.
		$a = b$ (Å)	c (Å)	
Y-Ba	0.4	3.828	12.68	Allge
La-Ba	0.05	3.782	13.168	Skelt
	0.075	3.7817	13.2487	Yuzz
	0.075	3.787	13.31	Fujit
	0.1	3.791	13.35	Fujit
La-Sr	0.05	3.7839	13.211	Taral
	0.05	3.78	13.25	Hidak
	0.063	3.7784	13.216	Taral
	0.075	3.7793	13.2	Decro
	0.075	3.7771	13.226	Taral
	0.075	3.776	13.234	Shelt
	0.075	3.772	13.247	Brunz
	0.087	3.7739	13.232	Taral
	0.1	3.7739	13.23	Taral
	0.1	3.777	13.2309	Przys
	0.112	3.7708	13.242	Taral
	0.125	3.7685	13.247	Taral
	0.132	3.7666	13.255	Taral
	0.15	3.7657	13.259	Taral

^aThe table is sorted by cations and then by increasing x , the dopant parameter (prepared by M. M. Rigney).

^bThe a and b lattice parameters were converted from measured values of a_0 , b_0 of Fig. VI-3 through the expression $a = a_0/\sqrt{2}$, $b = b_0/\sqrt{2}$.

Copper atoms and one of the oxygen types O(1) are in special positions; the remaining two atoms La and O(2) are in general positions with a single undetermined parameter associated with the z coordinate. The space group is $Fm\bar{m}m$, D_{2h}^{23} , and the positions of the atoms are as follows:

La	(8i)	$0,0,u; 0,\frac{1}{2},\frac{1}{2}+u; \frac{1}{2},0,\frac{1}{2}+u; \frac{1}{2},\frac{1}{2},u;$ $0,0,-u; 0,\frac{1}{2},\frac{1}{2}-u; \frac{1}{2},0,\frac{1}{2}-u; \frac{1}{2},\frac{1}{2},-u$	
Cu	(4a)	$0,0,0; 0,\frac{1}{2},\frac{1}{2}; \frac{1}{2},0,\frac{1}{2}; \frac{1}{2},\frac{1}{2},0$	(VI-9)
O(1)	(8e)	$\frac{1}{4},\frac{1}{4},0; \frac{1}{4},\frac{3}{4},\frac{1}{2}; \frac{3}{4},\frac{1}{4},\frac{1}{2}; \frac{3}{4},\frac{3}{4},0$ $\frac{1}{4},\frac{1}{4},\frac{1}{2}; \frac{1}{4},\frac{3}{4},0; \frac{3}{4},\frac{1}{4},0; \frac{3}{4},\frac{3}{4},\frac{1}{2}$	
O(2)	(8i)	$0,0,v; \dots$ (same as La with v replacing u)	

where the parameters $u = 0.362$ and $v = 0.182$ have the same values as in the tetragonal case presented above. Since u and v are the same and the lattice constants are so close to the tetragonal values, the sketch of the tetragonal unit cell in Fig. VI-5a applies here also. Another work (Hirot, see also Onoda) assigned

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superconductors

TABLE VI-5. Selected Lattice Parameters for $(R_{1-x}M_x)_2CuO_{4-\delta}$ Type Superconductors with the Orthorhombic Structure^a

Lattice Parameters							
Ref.	R-M	x	a (Å)	b (Å)	c (Å)	ANIS	Ref.
Allge	La-Ba	0.02	3.786	3.811	13.17	0.66	Fujit
Skelt		0.075	3.786*	3.808*	13.257	0.58	Shelt
Yuzzz		0.075	3.798*	3.803*	13.234	0.13	Onoda
Fujit	La-Ba	0.1	3.786*	3.824*	13.264	1.00	Hirot
Fujit	La-Ca	0.075	3.772*	3.808*	13.168	0.95	Shelt

^aANIS is the anisotropy factor $100|b - a|/0.5(b + a)$ (prepared by M. M. Rigney).^bThe a and b lattice parameters were converted from the measured values of a_0 , b_0 of Fig. VI-3 through the expressions $a = a_0/\sqrt{2}$, $b = b_0/\sqrt{2}$.

$(La_{0.9}Ba_{0.1})_2O_4$ to the space group $Pccm$, D_{2h}^3 with $a = 5.354 = 3.786\sqrt{2}$ Å, $b = 5.408 = 3.824\sqrt{2}$ Å, and $c = 13.264$ Å.

4. Phase Transition

The compounds $(La_{1-x}M_x)_2CuO_4$ with $M = Sr$ and Ba are orthorhombic at low temperatures and low M contents, and tetragonal otherwise, and superconductivity has been found on both sides of this transition (Baris, Bedn3, Birge, Dayzz, Dvora, Fujit, Gree1, Kangz, Koyam, Mihal, Paulz; see also Heldz). The prototype compound La_2CuO_4 itself also exhibits the tetragonal-to-orthorhombic transition. The phase diagram of Fig. VI-6 shows the tetragonal, orthorhombic

prepared by M. M.
of Fig. VI-3 through

positions; the
single undeter-
group is $Fmmm$,

(VI-9)

g u)

values as in the
the lattice con-
agonal unit cell
(noda) assigned

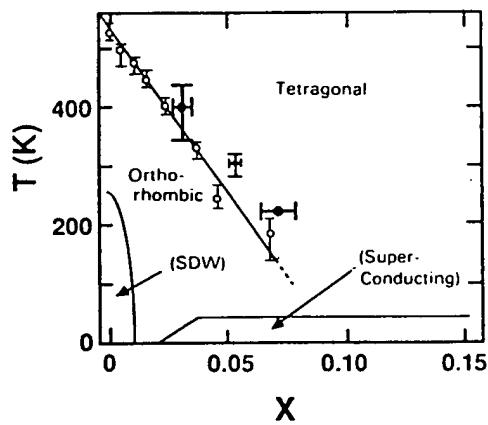


Fig. VI-6. Phase diagram showing data points along the tetragonal-to-orthorhombic transition line for $(La_{1-x}Ba_x)_2CuO_{4-\delta}$ (\circ , Fujit) and $(La_{1-x}Sr_x)_2CuO_4$ (\bullet , Moret). The spin-density wave (SDW) and superconducting \bullet regions are indicated. These two compounds have about the same superconducting region.

G 1416

bic, superconducting, and spin-density wave (SDW) regions for the barium compound (Fujit), and data points for the strontium compound (Moret, More8). An alternate phase diagram has been proposed (Ahar1). Alkaline metal contents much larger than those shown on the figure (e.g., $x \approx 0.5$) can be non-superconducting. The SDW region occurs below the minimum concentration for the onset of superconductivity. Another work (Geise) showed that LaSr(0.04) undergoes a structural phase transition between 180 and 300 K.

5. Generation of LaSrCuO Structures

The LaSrCuO tetragonal structures may be visualized as being derived from four LaCuO_3 perovskite unit cells of the type illustrated in Fig. VI-1 stacked one above the other along the z or c axis. To generate La_2CuO_4 in the K_2NiF_4 structure the layers of CuO_2 atoms on the $z = \frac{1}{4}$ and $z = \frac{3}{4}$ levels of this four-cell stacking are removed, La and O are interchanged on two other layers, and the middle layer Cu atom is shifted from the edge to the center point ($\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$) of the unit cell. Then the cell is compressed vertically from 14.9 to 13.2 Å (Table VI-4) to take up the space formerly occupied by the removed CuO_2 layers. Finally, the lanthanums along the c axis and the oxygens along the side edges are shifted vertically to accommodate the new atom arrangement.

To generate La_2CuO_4 with the Nd_2CuO_4 arrangement from this same four-cell stacking all of the oxygens on the vertical edges are removed, and two lanthanums are moved to edge sites. Copper is handled the same way as before, so in both cases the generated structure lacks two CuO_2 layers.

6. Layering Scheme of LaSrCuO

When we described the LaSrCuO structures we left out what is perhaps their most important characteristic, namely, their layered aspect. Lanthanum copper oxide may be looked upon as consisting of Cu-O layers of square-planar coordinated copper ions with lanthanum and O(2)-type oxygen ions populating the spaces between the layers. These Cu-O layers are stacked equally spaced, perpendicular to the c axis, as shown in Fig. VI-7, and their oxygens are aligned along the c axis, as indicated by the vertical dotted line on the left side of the figure. The copper ions, on the other hand, are not aligned vertically, but rather alternate between (000) and ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$) sites in adjacent layers, as illustrated in Figs. VI-5 and VI-7.

The copper is actually octahedrally coordinated with oxygen, but the Cu-O distance of 1.9 Å in the CuO_2 planes is much less than the vertical distance of 2.4 Å between copper and the oxygens above and below, as shown in Fig. VI-8. When the structure is distorted orthorhombically the Cu-O spacings in both the planes and the c direction remain quite close to their tetragonal counterparts.

The copper ions and the O(1)-type oxygens in the planes are both in special sites in the tetragonal and orthorhombic forms, in accordance with Eqs. (VI-6) and (VI-9), and as a result the plane is perfectly flat in both cases. When the

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